Keep Your Card in This Pocket

EXPLANATION OF FRONTISPIECE

1. *Liguus fasciatus testudineus Pilsbry.* Brickell Hammock, Miami.
2. *Liguus fasciatus lineolatus Simpson.* Totten's Key, Upper Keys.
3. *Liguus solidus lineatus Simpson.* Lignumvitæ Key, Upper Keys.
4. *Liguus fasciatus castaneozonatus Pilsbry, var.* Paradise Key, Dade Co.
5. *Liguus fasciatus elegans Simpson.* Island S.W. of Paradise Key.
6. *Liguus fasciatus roseatus Pilsbry.* Long Key, Everglades.
7. *Liguus crenatus marmoratus Pilsbry, var.* Brickell Hammock, Miami.
8. *Liguus fasciatus alternatus Simpson.* Timb's Hammock, Dade Co.
9. *Liguus fasciatus castaneozonatus Pilsbry, var.* Key Vaca, Upper Keys.
10. *Liguus crenatus eburneus Simpson.* Timb's Hammock, Dade Co.
11. *Liguus fasciatus hybrid.* Paradise Key, Dade Co.
12. *Liguus fasciatus versicolor Simpson.* Long Key, Everglades.
13. *Liguus solidus lignumvitæ Pilsbry.* Lignumvitæ Key, Upper Keys.
14. *Liguus fasciatus roseatus Pilsbry, var.* Long Key, Everglades.
15. *Liguus fasciatus castaneozonatus Pilsbry.* Paradise Key.
16. *Liguus crenatus septentrionalis Pilsbry.* Fort Lauderdale, Broward Co.

(Reduced one-fourth in length)

In
Lower Florida Wilds

A Naturalist's Observations on the Life, Physical Geography, and Geology of the more tropical part of the State

By

Charles Torrey Simpson

With Sixty-four Illustrations and Two Maps

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To

JOHN BROOKS HENDERSON

FRIEND AND COMPANION OF MANY CRUISES AND SCIENTIFIC EXPEDITIONS, THIS BOOK IS GRATEFULLY DEDICATED

INTRODUCTION

THE following pages are the result of observations and experiences in the wilds of the lower part of Florida during more than twenty years of residence in the region. From 1882 till 1886 I made my home on the southwest coast of the State and have lived near Miami since 1902. When I first came to the State the greater part of Lower Florida was an unbroken wilderness, and during the time I have been here I have quite thoroughly explored the territory described in this volume both as a collector and general naturalist. To-day most of its hammocks are destroyed, the streams are being dredged out and deepened, the Everglades are nearly drained; even the pine forests are being cut down. At the time when I first resided in the State flamingos, roseate spoonbills, scarlet ibises, and the beautiful plumed herons were abundant. Deer and otter could be seen at any time and the west coast waters were alive with immense schools

of mullet and other fish, while manatee were not rare. The streams and swamps were full of alligators; in fact the wonderful wild fauna of our region filled the land and the waters everywhere. It has seemed to me fitting that some record of this life should be made, in view of the fact that it is so rapidly disappearing—and forever. Already a number of species of our animals and plants are exterminated from this the only area in the United States in which they have ever been found.

In writing of our animals and plants I have made no attempt to use the very latest scientific names applied to them. Every new manual changes a large proportion of these, for our scientific nomenclature seems to be in an unhappy period of transition.

I am under great obligations to Mr. John B. Henderson for repeated cruises made with him in his dredging boat the *Eolis*, and for many collecting trips in Cuba, Jamaica, Haiti, and the Bahamas, where I was able to study much of the tropical life of Lower Florida where it originated; also for much assistance in preparing this volume.

Dr. John K. Small, of the New York Botanical Garden, has been my companion and mentor during a great many collecting trips in our terri-

tory, and has most generously placed at my disposal a large number of photographs made by him in the almost untrodden wilds. Mr. Charles Deering has shown me unnumbered favors in making me a member of collecting expeditions on his boat the *Barbee*. Mr. Wilson Popenoe of the U. S. Department of Agriculture, Professor Frances G. Smith of Smith College, and Dr. Roland Harper have furnished a number of photographs and rendered valuable assistance. Dr. E. H. Sellards, former State Geologist of Florida, contributed the map showing the Pleistocene subsidence and has made valuable suggestions. Mr. E. Ben Carter, Chief Engineer of the Florida East Coast Railway, has kindly allowed me to use the excellent map of a part of Monroe and Dade counties which was made from surveys for the extension of that road.

The map accompanying the text of this volume was drawn by the author in pencil and inked and lettered by Mr. Forrest Clark. The fine work of the map of the East Coast Railway has been freely copied with the permission of Mr. Carter.

C. T. S.

Little River, Florida,
April 22, 1919.

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In Lower Florida Wilds

CHAPTER I

The Building of the Land

THE observant visitor in Florida will find much that is interesting and surprising; some things indeed that may be quite beyond his comprehension. He will notice that there are no mountains or high hills, that the general region is flat and but slightly elevated above sea level. He will observe that the drier part of the State is largely composed of sand sometimes blown into dunes; that the many sluggish streams have hardly any valleys, and that the greater part of the territory is covered with a monotonous open growth of long leaved pines, with here and there stretches of denser forest composed of hardwood trees and shrubs, called "hammocks." Occasionally there is a swamp

which may consist largely of gray cypress trees with swollen, conical bases, while scattered thicklv over the swamp floor are blunt leafless stubs from one to six feet long, thrust up out of the mud—peculiar growths which spring from the roots of these trees.

If the stranger visits the lower part of the State he will find in the interior a vast extent of wet, often inundated prairie with wooded islets scattered along its borders. At the north of this great swamp, the Everglades, is Lake Okeechobee, which during the rainy season overflows the entire prairie. A low rocky ridge lies between the Everglades and the Atlantic shore. It projects westward far into the swamp in southern Dade County, and finally disappears in the great prairie. This ridge is cut into numerous islands, and water from the Everglades passes through the channels between out to the sea.

To the southeast, southward, and southwest of the mainland is a long chain of islands, the "Florida Keys," which extends in a great curve to the south and west, ending far out in the sea with the Tortugas. The upper islands of this chain are long and narrow, running parallel with the Gulf Stream,

and are of coral formation. The lower islands are of oolitic limestone and many of them run almost directly across the axis of the chain. If the visitor is a botanist he will find that the flora of the southeast mainland differs decidedly from that of the upper islands, although but a few miles distant, and also that many plants of the upper chain are not found on the lower group.

The observer will also notice that almost everywhere along both coasts of the State and separated from the mainland shore by narrow sounds there is a series of long islands or peninsulas, generally parallel with the shore, composed of sand and often covered with vegetation. He will find that in the lower part of Florida the protected shores of these islands and of the mainland are usually bordered by a dense growth of mangroves standing high on stilted roots and often reaching well out into the water. These trees help in a wonderful manner to build up the land.

If our visitor be a Nature lover he will ask why is this great area so low and flat; why are there no stream valleys; why should the State be pine covered with only here and there an island-like hammock? Why so sandy, and whence came

the sand. What causes the curious growth of the cypresses; how and when were the Everglades and the great Okeechobee formed; how comes the rocky ridge along the eastern coast? Why do the keys parallel the Gulf Stream; why are the upper ones long and narrow and what caused them to trend in the direction of the chain while most of the lower ones range across it? What is the cause of the difference in the floras which are separated by only a few miles of swamps or shallow sea? Why do the mangroves stand high on stilted roots, often with no trunk at all at their bases? These and many other questions are asked by the inquisitive stranger, indeed by those who long have lived here. In this and following chapters I shall attempt to answer most of these queries and to explain other things Floridian not easily understood at first. In some cases the geologic evidence seems to be so completely obliterated that we can only guess at a solution; in others we must wait for more careful and complete investigation before we can reach very satisfactory conclusions.

At some fairly remote period in geological time a great plateau was thrust up from the depths of

the sea by a folding of the earth's crust at the southeastern corner of the North American continent. This plateau has an average width of about three hundred miles and is of very nearly the same length. Its borders everywhere slope rapidly down into the abysses of the ocean. The eastern half of this plateau, which is the more elevated portion and now projects above the sea, is the present peninsula of Florida. This peninsula is shaped very much like the handle of an old-fashioned pistol. The northern or "continental" part of the State somewhat resembles the short barrel of the same, which is pointed directly at the States lying to the westward. The tract of land at the mouth of the Apalachicola River might answer for a trigger case. I once called the attention of an old Georgia cracker to this peculiar form, and after looking closely at the map for a minute while he slowly traced the outline with his finger he remarked: "Hit shore does look some like a pistol. Y'all don't reckon they wanted to fight, do ye, when they laid hit out thataway?"

The surface or topography of the State is, geologically speaking, quite new, there being within its borders no rocks observable older than

the Vicksburg group of the Upper Eocene. The presence of coal or carbonaceous matter has recently been reported from wells at a depth of about a thousand feet in Marion and Pasco counties, and this would indicate that at the time the coal was formed the surface of that part of the peninsula (a thousand feet below the present surface) was elevated to at least a short distance above sea level. As there are no evidences of any violent disturbances throughout the entire area we may presume that for a long time after the deposition of this carbonaceous material there was a gradual subsidence, and that the land was slowly built up by marine deposits at about the same rate at which the whole was subsiding. The entire area of Florida south of a line from Tampa to Daytona is very recent, as it belongs to the latest of the geologic periods—the Quaternary.

The region lying south of a line drawn from Cape Romano on the west to about Fort Lauderdale on the east may be designated as Lower Florida and this includes practically all of the State which has any claim to being called tropical. It embraces all the territory occupied in Florida by the large Cuban and West Indian arboreal

snails with their beautiful shells and probably all the region in which a *majority* of the native plants have been derived from the Torrid Zone. It is true that the flora of the seacoast littoral for a considerable distance north of these two points has been derived from Middle America, but, as I show elsewhere, it is subject to occasional destruction by frost. A few very narrow strips of West Indian trees and plants found immediately along the beaches on dry land for some distance up the peninsula owe their existence only to their immediate proximity to the sea.

During early or middle Pleistocene time (geologically speaking, only yesterday) a considerable subsidence took place throughout the peninsula of Florida, and all the lower part of the State (to north of the Caloosahatchee River) was sunk below the level of the sea. Most of the rock of the southern part of the State was formed under water during this period of depression. If, by any possibility, any of it had been above the ocean before this time, the flora and fauna inhabiting it were either drowned or driven to the northward. The story of the building of the land, so far as we need to trace it, may begin with

this Pleistocene submergence—this depression of "yesterday."

It was probably at this time that the great coral reef along the Floridian border of the Gulf Stream was started, and grew until it finally appeared at the surface of the sea. After being worked over by wave and storm action and with slight further elevation it formed and then became the present Upper Keys. This reef lay on a bank at some distance from what was later to become the mainland and was nourished by the warm, food-laden waters of the great ocean river that swept along it. When it had been built up to near its present height another coral reef or fringe began to grow up outside it and this is the present outer reef, which we shall visit in a later chapter.

During this same period of subsidence extensive beds of shallow water limestone were deposited over much of what was later to become our present Lower Florida. One of these limestone beds, an oölitic, covered the area which has since become the present region of the Lower Keys, and it is quite possible that this same formation extends to and includes all the present southeast coast where the rock is called by geologists the "Miami lime-

stone." This "Miami limestone" is usually believed to be of coral formation but it is really a shallow water oolitic limestone with a few corals mixed in here and there. On the southwest coast the "Lostman's River limestone" was probably laid down at this time and in the area now the interior of the Everglades a similar shallow water limestone was deposited.

Towards the close of the Pleistocene (geologically speaking at this morning's dawn) a period of elevation took place. Then for the first time the lower part of the State assumed essentially its present form, covering much the same area it does to-day. It is probable that during the time of this gradual elevation the rocky ridge (already referred to) lying between the Everglades and the Atlantic was built up. Beginning at Little River, though with occasional outcrops for some distance northward, and extending to its extreme southwest end, this ridge is composed of a soft oolitic limestone and is but a few miles wide, now broken into a series of "islands." It reaches well down into the Everglades, then turns to the westward, then to the southwest, and finally ends within five miles of Whitewater Bay. The water

of the Everglades drains freely through this porous rock, sometimes in wide prairie-like channels between the "islands" and sometimes it appears as springs on the eastern side of the ridge. This rocky ridge, which Dr. John K. Small has appropriately called "The Everglade Keys," is surely a series of ancient sea beaches, formed one after the other during the gradual elevation of this area. This is indicated by the strata being greatly cross bedded throughout a considerable part of it. In places between these old beaches the water must have been sheltered and quiet, as is indicated by many fossil bivalve shells found clinging together in a natural state. A northern sandy part of this ancient shore line overlaps the rocky ridge and was deposited at a later time. This ridge was the great highway over which plants and animals from the American tropics migrated northward and those from the north came southward.

In all probability the Everglades (which we shall personally inspect in another chapter) began to develop at about this time. The upper part of the chain of keys, doubtless in process of formation before the time of this uplift, was then thrust up,

and many of the corals, because of exposure to the atmosphere, were killed. The sea broke up the exposed surface of the reef, worked it over, and scattered the debris, forming thus a wide foundation for future growth of coral.

Samuel Sanford has claimed that this, or some more recent or subsequent uplift, carried the land to perhaps two hundred feet above its present level. Had there been so great an elevation all Lower Florida, including the keys, together with the present bays and sounds necessarily would have been continuous dry land. As the area is not large, its surface flat, its structure quite uniform, and its climate throughout, especially near the sea, quite the same, it seems certain that had so great an uplift ever taken place there would be to-day but one common assemblage of dry-land animals and plants throughout, or in the warmer part, at least, of the region. There can be no doubt that *most all* of the species would have been distributed over the *entire* territory. This, however, is not the case. Actually we find three more or less circumscribed areas of dry-land life occupying Lower Florida. First, the Lower Keys are inhabited by an almost strictly tropical flora, and within their borders there are

about one hundred species of native plants which are found nowhere else in the United States. *Liguus solidus*, a large, beautiful arboreal snail, exclusively occupies these islands and has formed several well marked subspecies, but it does not occur on the mainland. One particular form which may have originally sprung from it is found on Lignumvitæ and on Lower Matecumbe keys of the upper chain, but it probably reached these islands by drifting from the lower chain. Another large tree snail (*Oxystyla resus*) has evidently developed on the Lower Keys and is only found elsewhere on Key Vaca, an island of the upper chain but lying close to the lower ones. *Hemitrochus varians*, a finely colored Bahaman snail, is abundant on the southeast coast and Upper Keys, but is not found on the lower ones. A native cotton rat and a cotton mouse, which I shall mention elsewhere, occur abundantly on the upper chain of islands but never on the lower. So far as we know, no mammals are indigenous to any part of the lower group.

The mainland of the Miami region, including the rocky ridge just mentioned, has a mixed flora, a majority of its species being migrants from the

American tropics. These are, to a very considerable extent, identical with plants found on the Lower Keys. A little over a third of its flora is temperate and warm temperate, having migrated by land from the northward since the beginning of the land elevation. Only a few of these hardier northern plants occur on the keys. It is probable that the Lower Keys formed a single island during the time of this uplift, at which time the Miami mainland was first elevated above the sea. For a long time seeds and animals were carried northward by the Gulf Stream and established simultaneously on both of these land bodies while the present Upper Keys were only a living coral reef. In all probability the present south shore of the mainland was under water at that time and the same is doubtless true of the present southwest coast. Had the Upper Keys been elevated above the sea at that time they would have proven a rather effectual barrier to the landing of tropical life along the old Miami shore.

The Upper Keys, the extreme southern part of the mainland, and the lower southwest coast are inhabited by a common assemblage of plants, and, to a considerable extent, of animals, which differ

somewhat from those of the Lower Keys and the Miami mainland. There was an old landway, now wholly submerged and quite dissolved away, which reached across from Lower Matecumbe Key to the mainland east of Flamingo. Before the Florida East Coast Railway dredged a channel across the mud flat back of Matecumbe it would have been possible by following the tortuous shoals actually to wade from it to the mainland near Joe Kemp's Key, a distance of fully thirty miles, in water nowhere more than two feet deep. In fact there is now an extensive series of shoals lying along the inside of the Upper Keys from Duck Key to Largo (a distance of twenty-five miles) which stretches all the way across to the mainland with only here and there an enclosed basin of six or seven feet depth. For the most part, these shoals are continuous.

East of these shoals at the head of Florida Bay, an uninterrupted body of water from six to seven feet deep extends across from Key Largo to the mainland. This together with the extensive swamp to the northwest of it has acted as a barrier to the passage of dry-land plants and animals from the Upper Keys and also from the ham-

mocks along the south shore of the State over to the rocky ridge east and south of the Everglades.

The northern end of the upper chain of keys is not more than eight miles distant from the rocky ridge on the Miami mainland. Key Largo has been connected with the mainland until recently but the connection was a swamp never sufficiently dry to permit the passage of upland forms of life. Notwithstanding the nearness of these two bodies of land and the fact that they are only separated by the shallow waters of Biscayne Bay, Card and Barnes sounds I feel safe in asserting that there has never been an elevation sufficient to unite them as *dry land* since the present life reached their shores. Nor, on the other hand, has there been any subsidence great enough to drown out our dry-land flora and fauna since they were first established. I do not believe that since the first Pleistocene elevation there has been twenty feet of change in elevation in all Lower Florida.

At least sixty species of tropical plants are found on the Upper Keys which do not occur on the Miami mainland and a large temperate and warm temperate flora grows on the latter which is entirely absent from the former area. There are

more than 140 species of tropical plants common to this mainland and the Lower Keys *which do not occur on the Upper Keys at all!* I can conceive of no better evidence that the Miami coast and the Lower Keys (which are likely of the same geological formation), though they were perhaps never actually connected, were above the sea and were receiving life drifted from the American tropics a long time before the Upper Keys had become dry land. If I am correct the Lower Keys should be far richer in tropical life than the upper ones. This is in fact the case for 440 such species of plants have been reported from the former area as against 265 from the latter. Yet there is but little difference in the extent and surface features of the two groups of islands. It is doubtful that they have ever been connected by dry land. The Moser Channel lying west of Knight's Key (of the upper chain) and eastward of the lower chain carries through a full nine feet of water from the Gulf of Mexico to the Florida Strait, and this channel has probably separated the two groups of islands or keys from the time when the present tropical flora and fauna first began to arrive.

The distribution of the animals of Lower

Florida is not so well known as is that of the plants, but it is certain that we have many tropical species of the former within our borders. I have seen a large collection of butterflies made near Havana and more than half of its species are also Floridian. I do not know that any naturalist has identified all our other insects. We have about forty species of land and fresh-water mollusks in Florida of tropical American origin and of these at least a dozen have developed into distinct species since they arrived here. It is probable that when our flora is fully investigated quite a thousand species of tropical plants will be found in Lower Florida, and of these, a considerable number, perhaps fifty, will prove to be endemic, that is they have developed into new forms since landing on our shores.

It has required a long time for the attainment of such results, for the process of establishing a flora and fauna by drifting and migration must necessarily be a slow one, and the development of species takes much time. Ages have been required for all this and it is not unlikely that twenty or twenty-five thousand years have elapsed since the mid-Pleistocene elevation began.

Some time after this mid-Pleistocene elevation there came a second subsidence, but only of a few feet. Along the low, rocky bluffs in and just north of Cocoanut Grove, erosion marks made by the surf are plainly visible. The same evidences may be seen in the great hammock south of Miami, its eastern rocky wall having been the sea-shore at the time of this slight subsidence. Now the southern end of this wall is quite a distance back from the bay though at the Punch Bowl the bluff comes out to the shore. The same erosion marks may be seen on a bit of rocky bluff on the north side of Little River, and along the walls of Arch Creek. There are old beaches on which long dead (but specifically recent) sea shells are scattered, in several places back from the western shore of Biscayne Bay and again at Boca Raton, north of Fort Lauderdale. These are six or seven feet above tide and correspond in height with the surf marks on the bluffs near the Punch Bowl. A similar shell beach on Big Pine Key of the lower chain, would indicate that the sub-sidence was not so great there, as it lies about three feet above the ocean. These old beaches mark the limit of the second subsidence and during

the greatest depression the sea entered the eastern border of the Everglades. At the same time the reef (which later became the Upper Keys), was still further built up and developed.

This second subsidence was followed by a second period of elevation, during which the corals of the reef slowly died and the sea again destroyed the surface of the reef, piling up debris, scattering the looser materials, and reshaping it into islands of coral rock. The reef was finally elevated sufficiently for the seeds of dry-land plants to germinate upon it and establish a flora. Lower Florida mainland was doubtless slightly higher at this time than it is at present, sufficiently so that the old land passage elsewhere mentioned from the mainland to the Upper Keys existed.

A third slight subsidence followed and is probably continuing at present. Now the old landway just referred to is submerged and its remnants are being destroyed by the solvents of the sea. While making excavations in a brackish swamp on my place I found stumps and trunks of live oaks and other trees below the present level of high tide, and these were undoubtedly in the localities where they grew. Sanford mentions seeing a thick

stump in gray marl on the southwest coast covered by water at high tide. He believes, as I do, that there is evidence at Cape Sable of a slight recent subsidence. On the outer shore opposite Lemon City the sea at one time since I have lived here, encroached on the sandy shore and uncovered peat of an old mangrove swamp which is now submerged at low tide. Along the south coast of the mainland the sea is eating into the beach to such an extent that mangrove and buttonwood trees are found for some distance out into the bay. Finally the great area of mangrove swamp which covers many thousands of acres in the Ten Thousand Islands and along the south and southeast coasts would seem further to indicate that a subsidence is taking place. This need not cause owners of bay front property in Lower Florida any serious alarm since it is probable that the mangroves and other shore vegetation are building up the land as rapidly as it subsides.

Beginning at the southeastern shore of Virginia, thence extending into Dade County, Florida, again appearing in Lee County, on the southwest coast of our State and then continuing with

occasional interruptions around the Gulf of Mexico to Yucatan, is a series of long, narrow, sandy islands and peninsulas lying parallel with the mainland shore and at no great distance from it. They are usually low; rarely rising higher than the limits of a storm tide, though in places they assume the character of sand dunes, with a little greater elevation. Between these islands and the main shore there are usually shallow lagoons sometimes called rivers, though their water is salt or brackish. In some places these lagoons fill up with sediment with little or no water remaining and thus form brackish swamps. It has often been asserted that these sandy coastal islands result from ocean currents running parallel with the shore which carry and deposit sand in long, narrow bars, constantly adding to these bars at the end where the retreating water leaves them. While this may be true in some cases I do not believe that the action of such currents alone has formed most of these islands. In some instances these narrow land bodies run parallel with the shores of bays where it seems unlikely that any ocean currents would sweep along the deeply incurved beaches. Besides this, such long-shore currents could only build up the sand

to the level of an ordinary high tide, while these elongated bars are generally considerably higher.

It seems more probable that these peculiar formations are caused by the action of the ordinary tides aided by occasional storms which sweep in upon the shore. Wherever a sandy sea bottom slopes very gradually from the beach the waves stir up the shifting sand for a long way off shore especially when strong tides are coming in or when high winds blow towards the shore. This disturbance of the water,—the ground swell, sweeps up the sediment and loose sand at a depth of several fathoms and often from a distance of some miles out. After severe storms during which the wind has blown towards the land, immense numbers of fish living in water of considerable depth are occasionally cast upon the beach, their gills choked with sand and mud. The water has been so greatly disturbed they have perforce breathed in the silt which they could not eject and have literally drowned.

As the shore is neared and the water becomes more shallow its landward movement is accelerated, so that in some places and under certain conditions it rushes in with considerable speed.

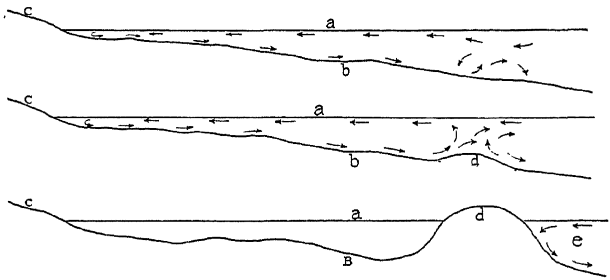


Diagram to Illustrate the Formation of Sand Islands and Peninsulas

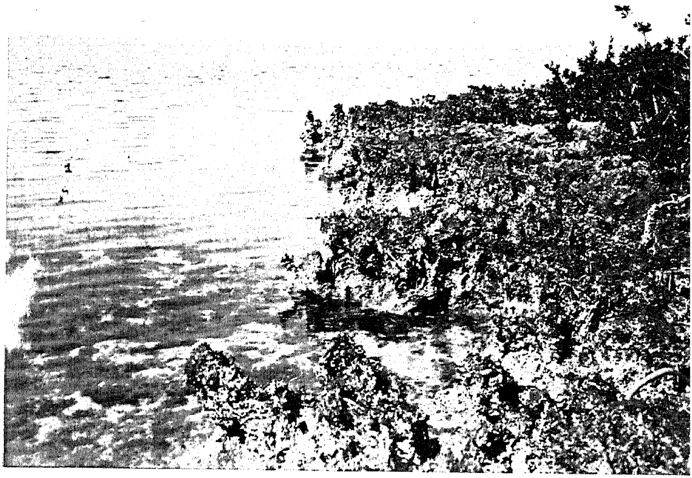
a, a, a, sea level, b, b, b, sea bottom, c, c, c, shore; d, d, ridge of sand formed off shore along slack water line, e Arrows show direction of currents.

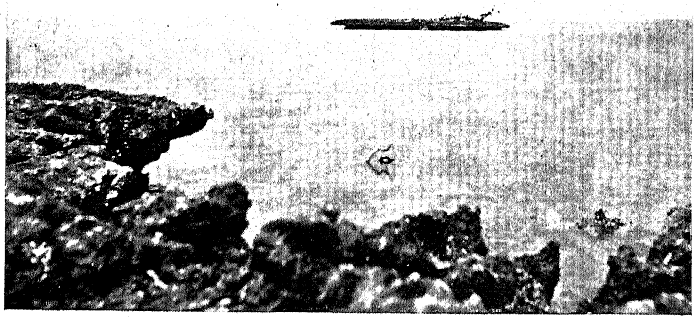
In Hawaii the natives with surf boards swim out from just such shores and upon the wave crests are swept in with great rapidity. At the beach the wave-formed current turns back seaward, retreating underneath into deeper water, rapidly at first and more slowly as the depth increases. This backward movement is called the undertow, and swimmers are sometimes carried by it out to sea. This outgoing undertow rapidly slackens because of its friction against the bottom and also against the incoming water above, and at a certain distance from the shore, by reason of this friction and of the increasing depth, it ceases to advance and mingles with the comparatively slow moving, incoming tide. All this water contains silt and often the coarser sand, but only a little of it is deposited between the beach and the line of slack tide well off shore because of its too rapid motion between these two points. Naturally a considerable quantity of sand and mud must be released and deposited where the undertow slackens and ceases to flow.

Thus a ridge of silt begins to form along the line of these mixed currents and slack water, parallel to the shore and at some distance from it. Once

begun the ridge acts as an obstruction to the incoming and outgoing tides, and more and more material is deposited on and against it from both within and without. Finally the ridge builds up to the level of high tide and a bay or so-called "river" is a result. More sand is heaped against the outside of the ridge during very high tides or incoming storms until eventually it becomes a long island or peninsula, sometimes ten feet or more in height. The wind may sweep the sand into dunes; seeds and the flotsam of the sea are cast upon it and the island is covered with a mantle of vegetation. Such a tidal peninsula has been formed between New River Inlet (near Fort Lauderdale) and Cape Florida, and the upper end of Biscayne Bay is the resulting "river" that lies behind it. Beginning at Snake Creek at the upper end of the bay and extending for some distance to the northward the space back of the tidal land has become filled with vegetable muck until it is now a swamp. There are generally open channels at intervals between the bays or "rivers" and the open sea, through which the tides rush swiftly.

Where the sea bottom slopes away very grad-





Upper View. Ragged Coral Limestone, Shore of Pumpkin Key, Upper Keys
Photo by Dr. John K. Small

Lower View. Small Coral Rock Key near Marathon, showing Erosion of the Sea and Overhanging Rock
Photo by R. M. Harper

ually often a second ridge is formed outside the first. Such may be observed at Cape Canaveral.

Now as against this constructive action of the sea in land building and extension there are many opposing forces of destruction to offset it. Upon every shore a contest is being waged by Nature's forces to build up, on the one hand, and extend the land seaward, and to destroy the land, on the other hand, and bury it beneath the sea. Thus the constant changes we may see from year to year along any beach.

Destruction of the land is chiefly caused by erosion and by the solvent action of both fresh and sea water. The surf is constantly bombarding the rocky beaches with crashing wave volleys while insiduously dissolving away the rocky shore by the chemistry of its waters. Even the spray thrown back from the shore, and forming pools in the depressions in the limestone, gradually destroys the hard rock much as some corrosive acid would do. Between tides the water constantly erodes and dissolves the limestone rock, often causing a shelf to overhang for fifteen or twenty feet. From above, the little holes of erosion become eaten through, and every wave that thunders

in sends up spouts of solid water and spray. By and by the overhanging shelf becomes weakened and finally breaks off by its own weight or from a particularly vicious blow from the sea.

I know of no word or combination of words which would properly describe the sharpness, the raggedness and jaggedness of some of these rocky beaches along the Upper Keys. Compared with them the rocky road to Dublin is a smooth, macadam turnpike. Most of the rock of these keys is very porous and the water from the heaviest of rains immediately sinks through it to tide level, dissolving always more or less of it as it passes along. Whenever there is a high tide on the ocean side there is sure to be a correspondingly low one inside or in the bays. Then especially strong currents of sea water sweep through and under the rock from the flood to the ebb side taking heavy toll of rock substance as they pass. I have counted as many as twenty streams of sea water issuing from the outer side of old Rhodes Key in a distance of as many rods, at a time of low tide on that side of the island and high tide on the other. Some of them were mere trickles but a few were good-sized currents.

Eventually a weakened roof collapses over one of these water passages but the debris is soon dissolved and washed out and in time an open passage from ocean to bay is formed. There will be deep holes and shallows in these passages, and along their banks mangroves may find lodgment, sometimes even on the bare rock. The tides rush through the newly made passage constantly eating away its banks until the two sides are widely separated. Many if not all the keys have been more or less divided in this manner and are still being worn away. The Ragged Keys, a set of rocky islets at the northern end of the chain (and most appropriately named), are striking examples of this scouring and dissolving power of the sea. According to A. J. Sands and Otto Matthaus, both long residents of the region, Ragged Key Rock was, but a few years ago, about fifty feet across and supported trees and shrubs. The sea completely undermined it and then a severe storm completed the wreck. Now there remains but a small rock visible at low tide. It is not unlikely that within a few centuries past this now submerged rock was a part of a long island lying to the south of it. The present gradual sub-

siding of this region certainly aids the sea very materially in the destruction of the land. There is no reason to doubt that the bays along the south and southeast mainland coasts are slowly deepening and encroaching upon the land.

The sea water cannot dissolve *all* the limestone which it destroys but it leaves a small residue. This residue serves to augment the mud flats of the bays and tidal channels. This is well seen at the mouth of Cæsar's Creek and in the several passages between Largo and Elliott's keys. In his *Observations upon the Floridas*, published in 1823, Charles Vignoles stated that Key Largo was a peninsula, connected with the mainland by a portage of six boat-lengths, though now a navigable channel separates the two. A cotton rat (*Sigmodon hispidus*) and a cotton mouse (*Peromyscus gossipium*) both dry-land and swamp-frequenting animals, but not swimmers, are found on Key Largo, which would indicate that there was formerly a land connection between the mainland and the island. It is quite probable that the water passage separating the two bodies of land may be due to both solution and subsidence. The former connecting neck of land did not, how-

Young Mangroves Growing on Naked Coral Rock, Lower Matecumbe Key

Photo by R. M. Harper

ever, permit the migration across it of the highland vegetation as the mainland just back of it was a great swamp.

The dissolving of the soft limestone rock is nowhere more evident than in the pine woods bordering the Everglades. Before the recent drainage of this region the glade lands were covered with fresh water throughout the rainy season, and sometimes during the entire year. Rain water absorbs a considerable amount of carbonic acid or carbon dioxide as it falls through the atmosphere, and much more is added to it by decomposing vegetation. This Everglade fresh water often extends well out over the low pine woods and has carved the rocky forest floor until it is quite as rough and ragged as is that of the keys. Hence the irregular sinks and many potholes, and the uneven surface of villainous knife-like edges which render walking over it a really hazardous undertaking. In places the honey-combed rock becomes so undermined and rotten that it breaks under the tread, but woe unto him who falls upon it!

So level is the general face of the country that surface water sometimes seems undecided which

way to flow. It must then go downward through the porous rock, eventually reaching the sea by underground channels. Into these the tide often flows back for long distances.

Wherever along the coast there is a slight elevation it is dignified (in a double sense) by being called a "bluff"; every gentle swell of the surface is at least some kind of "heights"; some even apply the name "mount" to their estates. Verily all things are relative!

The widespread mantle of sand which covers most of the drier part of the State is composed of grains of quartz. On the coasts it is mixed with finely broken marine shells. The problem of the origin of this siliceous sand is an interesting one. Just how it came to be dispersed over the whole region is also of interest. Doubtless it is of northern origin and some of it was washed down by the rivers of the Appalachian mountains. The cold return current which sweeps southward along the Atlantic coast constantly brings cargoes of it; the sea throws it up on the land and the winds disperse it. Some of it is a residue from limestone rocks formerly covering parts of the State but now destroyed by action of the air and water. The

blanket of sand reaches as far south as Miami and Cape Florida on the southeast coast, and to Cape Sable on the southwest. But the manner in which it has been so generally distributed over Florida in almost level beds, is probably not well understood. At these two points the siliceous sands rather abruptly cease and to the south the sand of the beaches is composed entirely of broken bits of coral, shells, and other marine growths,—with little or no trace of quartz or of the older rocks.

There have been no violent convulsions, no sudden or great disturbances during the geological history of Florida since the original uplift of the Florida bank, yet a ceaseless construction and destruction of land have been going on within its limits. The new land formed yesterday of silt washed down by streams, by elevation or by the deposition of vegetable matter, is being dissolved to-day by carbon dioxide, worn away by stream or surf action or carried below by subsidence.

CHAPTER II

The Florida Keys

LET us in fancy take a very large pair of dividers, setting one point at Cape Romano on the southwest coast of Florida, and the other at Miami and then sweep the latter point first south, then southwest, and finally west until it reaches a spot west of south of the central point. We have thereby fairly accurately marked the curved axis of a group of islands called the "Florida Keys." From Miami another but irregular curve to the south and west nearly coincides with the southeast and southern coasts of the mainland. These two curved lines begin together on the east coast but diverge as they make to the south and west so that when Key Vaca on the first line is reached, Cape Sable, which lies due north of it on the second line, is twenty-eight miles distant. The horn-shaped area of shallow water between which separates the keys and the mainland is the

Bay of Florida, Blackwater Bay, Barnes and Card Sounds.

The axis of the great island chain corresponds closely with the curve of the southern edge of the "plateau," the foundation of the Peninsula of Florida. It also marks the northern border of the Gulf Stream. The true keys begin at the north with Soldier Key, a little islet about eleven miles to the southward of Miami, though the reef rock reaches just a bit north of this island. They extend to the Tortugas, the westernmost island of the chain and distant from the first (on the axis), about one hundred and eighty miles. The islands vary in size from the tiniest bit of rock, sand, or mud, often crowned with a green boquet of mangroves, to Key Largo, almost thirty miles long. The crowning elevation is in the "knolls" at Windley's Island. Their dizzy height of eighteen feet in so flat a region gives them by contrast a real dignity.

Between the chain of keys and an outer reef paralleling it lies the Hawk Channel, a long, narrow body of shallow water with a maximum depth of six fathoms, and a width of from three to six miles. This channel extends from near Cape

Florida to the Marquesas Islands. The reef is largely formed of living coral, and is, no doubt, an incipient chain of keys. With a slight uplift a soil would soon be formed on the exposed reef, seeds would be washed upon it, a forest would grow and a second chain of keys, much like the present one would be the result.

Many years ago Louis Agassiz, the distinguished naturalist, studied the Florida Keys. He maintained that they, together with the entire southern part of Florida, were made up of coral reefs. He stated that the "shore bluffs" along the south part of the mainland were simply an ancient coral reef; that after crossing a flat expanse of land called "The Indian Hunting Ground" a series of elevations was reached which bore the name of "The Hummocks"; that seven such reefs and interspaces had been traced between the "shore bluffs" and Lake Okeechobee. He further believed that the entire peninsula was of coral formation and made an estimate of its age based on the normal growth rate of living corals.

There is no real foundation for these statements or theories, and if Agassiz had actually explored the mainland he certainly would have fallen into

no such error. There are no bluffs anywhere along the shore. I have been inland for a considerable distance from Cape Romano, Chokoloskee, Rodgers River, and other places along the southwest coast; and I am very familiar with Cape Sable and the country back of it; with Coot, Madeira, and other neighboring bays, and I have explored Cuthbert Lake along the south coast and there is no evidence of coral growth at any of these places. The Florida East Coast Railway enters the mainland on the southeast coast and runs through an unbroken swamp to Florida City, fifteen miles from the shore. The Flamingo region is alluvium and that to the east of it is marl, Cape Sable is a sand bank based on an old mangrove swamp. The Ten Thousand Islands are swamp with a few artificial mounds. Nowhere is there coral.

Because of its eminent originator this theory of the development of Lower Florida has been very generally accepted. The only possible foundation it could rest upon is the fact that a part of the keys and all the outer reef *are* built of coral.

A glance at the charts of the Florida Keys shows that the islands of the upper part of the chain

are long and narrow and that their axis is *paralle* with the edge of the Gulf Stream while the island: of the lower group are very different both in shap(and arrangement. The eastern islands of th(lower group are somewhat elongated but they li(*across* the axis of the chain. Those on the wes' are very irregular in form, constituting a small bu' amazingly complicated archipelago, in which ther(seems to be no systematic alignment whatever A careful inspection of the charts will also show that the upper chain of islands apparently blend: with the lower group leaving as doubtful in thei: true relationship Bahia Honda, the West Summer-land Keys, a narrow strip of land belonging tc the southern end of Big Pine Key, and the New-found Harbor Keys. With the latter keys, however, the upper chain seems positively tc end.

The upper islands are an old coral reef formerly built along the edge of the great peninsular pla-teau. It was subsequently raised slightly, sc naturally the chain consists of long, narrow island: running parallel with the Gulf Stream. I feel sur(that the lower group of keys is a remnant of what was once a single large island which lay along th(

northern part of this great ocean river and which had been raised above the sea by the first Pleistocene elevation. It extended from East and West Bahia Honda Keys (on the east) to Key West or possibly even further west, and from the Content, Sawyer, Johnson's, Mud, West Harbor, and Northwest Boca Chica Keys (on the north) to the inner edge of the Hawk Channel (on the south). While this large island was entire, and perhaps even since that time, various animals and the seeds of tropical plants were brought to it, largely by the Gulf Stream; these became colonized and finally generally distributed over it. At the time of the second depression (during later Pleistocene) the island subsided slightly, but not sufficiently to drown out completely its dry-land life. Its eastern end was lowered until the waters of the Gulf of Mexico occasionally swept over the lower portions during severe northers. I found sea shells of existing species scattered abundantly along the southwest shore of Big Pine Key at a height of about three feet above tide, and these probably marked the extent of the greatest depression. The water which was driven across the low land scoured out a series of parallel chan-

nels having a north-northwest, south-southeast direction and it is also likely that it formed passages under the rock which later became open tidal streams. Johnson, Little Pine, No Name, Big Pine, Torch, and Summerland Keys are long, narrow islands lying between these channels and conforming with them in general direction as do several bars which lie just east of these keys. The tidal periods differ in the Gulf of Mexico and in Florida Strait, hence there is a rush of water from one side to the other, which, even under normal conditions operates always to dissolve the rock and scour out the debris.

The westernmost of the larger north and south channels is between Sugar Loaf and Cudjoe Key and to the westward of this there is a different arrangement of land and water. Apparently this western area did not subside sufficiently to permit the water of the Gulf to drive across it so freely, hence, there are but a few small channels cut through. One channel seems to be now forming east of Big Coppitt and also another one west of Boca Chica. There are two or three other relatively small openings.

Several years ago in company with Dr. Pilsbry

of the Academy of Natural Sciences of Philadelphia I was storm bound during a very severe norther at the mouth of Pelot's Creek, a narrow passage east of Boca Chica. For three days the sea water, filled with silt to a coffee color, and bearing floating timber and all manner of rubbish, was driven through this little channel at the rate of ten miles an hour. Although it was early in April the strong wind was bitterly cold and we were obliged to get our launch into that creek where we would find the only shelter. It took three of us with the tow rope and the full power of the engine to get the boat in, and once or twice it very nearly broke away. The third day of our enforced stay Dr. Pilsbry became anxious to get to Key West en route home, and against the boatman's protests we made the attempt to leave. With a line from the stern to a mangrove we cast off forward and once fairly in the stream and with the engine full ahead we shot down the channel at railway speed. The wind had driven the sea a quarter of a mile away from the beach but through the channel across the beach we were swept at a terrific rate. The bow struck a bar and we whirled around like a top.

Before reaching the sea, we struck something side-on in a broadside rush that threw some of us overboard. There we remained miserably exposed to the fury of the wind for six or seven hours when the norther ceased, and the returning sea floated us. This will give some idea of the force with which the water is driven across the keys and its power to cut channels.

The greater part of the dry land (especially toward the western end of the archipelago) is found in its southern part. It may be this once formed a low, continuous ridge which acted as a dam to prevent the water of the Gulf from breaking across into the strait. The sea water, however, entered by seepage into the low, rocky land of the western part of the archipelago and by undermining has broken it down into a confusing irregularity of outline. There are places in some of the lagoons where the water is six or seven feet deep showing undoubtedly that the rock has been removed by solution.

Probably all of Ramrod and several other small keys have subsided slightly but enough to convert them into mangrove swamps. The dry-land vegetation upon them has been destroyed, and almost

no traces of any of the large arboreal snails are to be found.

Geologists believe that the islands west of Key West are of very recent origin, at least so far as their elevation above the sea is concerned. While those which lie between Key West and Boca Grande are of oolitic formation the Marquesas and Tortugas are composed of finely broken remains of various marine animals. At Tortugas extensive coral reefs have developed in the shallows along the edges of the land, the finest growth of this kind, perhaps, in the United States. The Marquesas, which consist of one large and several small islets, have an outline resembling a round-headed kite. The group is really an atoll, the outer keys forming a rim which encloses a shallow lagoon. It is not, however, a true coral atoll like those of the Pacific. The rock bed forming the foundation of the Marquesas was probably built up or elevated to very near the level of the sea. Wave action afterwards heaped up sand around the border and this now forms the dry land of the atoll. This sand covering has prevented or retarded dissolution of the foundation rock, but in the interior the less protected rock has been dis-

solved until a lagoon was formed. The Tortugas are believed to be an imperfect atoll, developed in much the same way as the Marquesas; so also is a minute island, "Key C," lying to the westward of Key West. Boca Grande is also a pseudo atoll of the Marquesas type.

In 1916 I visited the Marquesas for the purpose of finding a rare palm which had been discovered there several years before. As we drew near we sighted it among the thick scrub on the east side of the main island, and it proved at once to be a very distinct and handsome species. This is *Thrinax keyensis* of Professor Sargent only known from this group of islands and possibly from another small key of the lower chain. It has a stout, ashy gray stem, sometimes twenty-five feet high, raised on a conical base of matted roots. The shining rich green fan-shaped leaves have a brilliant silver color beneath, and are scattered for some distance along the trunk. It is really one of our most beautiful palms and quite distinct from any other in the State. Although unreported from any locality outside of this restricted area it is probable that it may yet be discovered in the Bahamas or West Indies. The islands on which

it has been found are so recent that it seems improbable a new species of palm could develop on them. With this we found also another, *Thrinax wendlandiana*, a native of Cuba but quite generally distributed over the Florida Keys and the south shore of the mainland.

Aside from the common littoral vegetation, the mangrove, Avicennia, Laguncularia, and buttonwood (which fringe all the keys) the only trees seen were the very common poison tree (*Metopium metopium*), *Pithecolobium guadelupensis* (also abundant in Lower Florida), and two stoppers,—*Eugenia buxifolia* and *E. rhombea*, the latter being confined in the United States to the Lower Keys. A few grasses and herbaceous plants were found and an intensive search brought to light but a single minute land snail, one of the Pupillidæ. The impression gained was that since the islet group formed there had been insufficient time for any considerable flora or fauna to develop.

But there are still younger keys in this region. Sand Key, about six miles southwest of Key West is one of these—a mere rick of broken corals, shells, and sand, heaped up by the sea. It is an island of to-day. Not over an acre in extent it is used

as the site of a light house and weather station. On it are a few herbaceous plants—the first forms which nature establishes on newly made tropic land. These are a Tournfortia, a cousin of the cultivated heliotrope, a hoary leaved half shrub with white blossoms; *Sesuvium portulacastrum*, a creeper on the sands with thick leaves such as many of the shore plants have, and with it the widespread goat's foot (*Ipomœa pes-capræ*). The latter has round, glossy leaves with a cleft at the apex, and large, handsome, purple flowers. With these are a few other salt loving plants.

On this tiny islet were immense numbers of the least tern (*Sterna antillarum*), which, at the time of my last visit, were nesting, if simply laying eggs on the open sand could be so called. All of the sandy portion of the key was used for this purpose, and the only preparation for nesting consisted in moving the fragments of coral sufficiently to offer a smooth place on which to sit. I saw no birds actually sitting on eggs; probably they do this only at night leaving the hot sun to do the work of hatching. They flew around us angry and screaming when approached,—a wholly unnecessary demonstration since they are protected by law

from any interference during their nesting season. This graceful little bird was formerly abundant along the Atlantic coast but is now becoming quite scarce. We were told that this is their only breeding place on the Lower Keys.

If, geologically speaking, Sand Key is an island born to-day there are others in the chain which are only just hatching. Western, Middle, and Eastern Sambo, lying east and south of Key West are such. So indeed is Looe Key, to the south of Ramrod Key, and also belonging to the outer reef. As yet these possess no vegetation whatever and the sea still breaks over them in heavy storms. At some distance out in the Hawk Channel in the vicinity of Key West is an incipient third reef lying within the outer one, and belonging to this are the Middle Ground, Washerwoman, Mississippi, and other shoals which are doubtless undergoing the process of being formed into keys.

This, then, is nature's workshop for the making of islands, in which can be traced every process from the first coral polyp that attaches itself to the bottom and starts an incipient reef to the completed island raised well above the highest normal tide; or, from a tiny bar of mud or sand

deposited by some wayward ocean current to a great key covered with forests and other minor vegetation. Here countless bacteria change invisible mineral elements in the sea water into impalpable mud which in turn hardens and becomes rock. Here the mangroves toil to gather together and lay a foundation for what shall later be fertile soil. The sea in unceasing restless movement brings in material from near and far and heaps it up into shoals and future islands. But then with seeming inconsistency it turns and angrily smites and washes away these islands of its own making; it tears up the solid rock which it built along the shores, smashing it into fragments and scattering it far and wide. By its own chemical warfare it destroys the very limestone fortress it built so well.

In seeming caprice the inconstant ocean creates the islands and devours them at the same time,—industriously building to-day—busily demolishing to-morrow. So delicately balanced are these opposing forces that the slightest change in conditions may cause the upbuilding to stop and the wrecking to begin. If the wind is gentle and sea smooth the constructive work progresses; if the

wind increases ever so little the waves tear down and destroy. Again, the very same forces may operate in exactly the opposite manner. But the work never stops,—constructive or destructive, it never ceases for one second.

The flora of the entire chain of islands is interesting, notwithstanding the terrible devastation that man has wrought upon it. It is mostly derived from the American tropics, the majority of the plants being Cuban. Nearly all the higher land was once covered with forest which varied from low dense thorny scrub to tall closely set growth. The latter has doubtless been long established and a considerable amount of leaf mold has accumulated. Usually in such hammocks the ground is level and the rock is buried beneath a vegetable humus. In this spongy soil where one often sinks shoe deep little undergrowth is seen. Some of the trees are of goodly girth and their straight trunks bear aloft dense heads of foliage. Such hammocks still exist on No Name, Pumpkin, Lignum-vitæ, Old Rhodes, Elliott's, and on Key Largo. A few years ago a hammock that was perhaps the finest and most extensive in the lower part of the State covered

the latter island for several miles in the vicinity of Cross Key. The Florida East Coast Railway cut a right of way through this for the Key West extension of its line and piled the felled timber along the edges of the clearing. When it was fairly dried out it was set on fire by sparks from the locomotives (so claimed) and this unfortunately communicated to the forest. For months the fire slowly ate its way through the peatlike soil and as it crept along its ruinous way the grand old giants of the hammock toppled and fell, a tragedy in every fall. Every vestage of the soil was consumed and to-day the charred ruin glares in the sun as a silent and pathetic protest against useless waste and folly. A few young trees are springing up here and there and thorny vines are beginning to scramble over the melancholy wreck. Nature will in time conceal her wound beneath a green mantle—but the fine forest is forever gone.

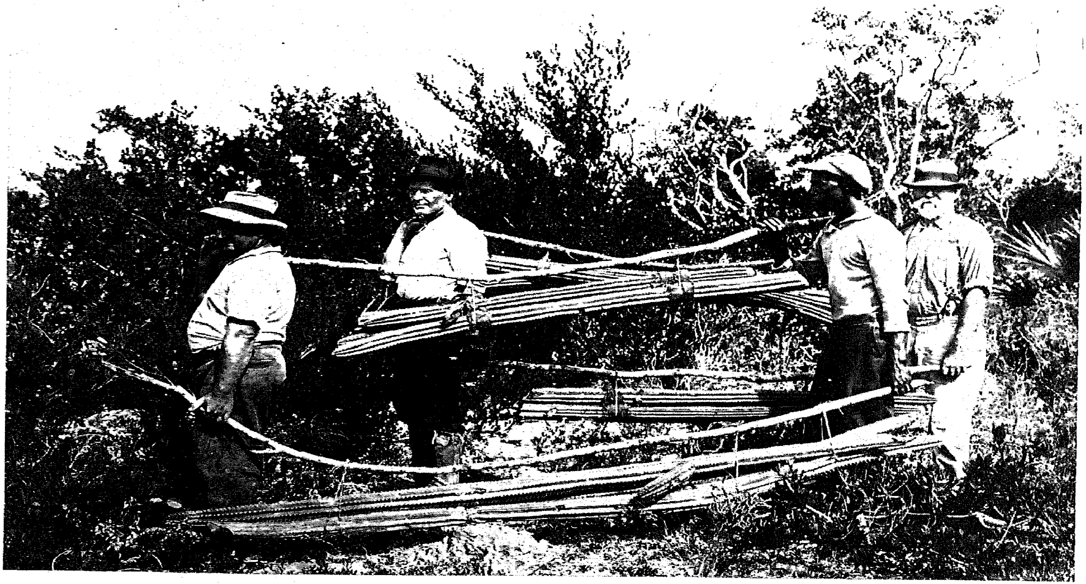
Several years ago there was an almost equally fine hammock on No Name Key but the settler's fire and ax have changed the greater part of it into a desert. In 1907 I became lost in a splendid forest of silver palms on Bahia Honda Key but

on making a search for these palms three years ago I found the spot on which they stood as bare as a prairie. On some of the Upper Keys the hammock was cut in order that its owners might plant pineapples. In places the surface of the islands was formerly a bed of broken rock and coral and on this the forest eventually sprung. Ages afterwards the rocky floor became overlaid with a deep coating of leaf mold, the patient work of nature in transforming the abundant growth into a fertile soil. As soon as the forest was destroyed the roots began to decay, the soil washed down through the bed of loose porous rock, and in five years nothing was left but the old original stony fields. Finally the pineapple crops were no longer profitable, failing as the soil departed. Now comes the experiment of lime trees, planted either on these bare rocky beds or in the virgin forest cut to receive them. Thus the hammocks on the keys are being rapidly destroyed and will soon be a thing of the past.

On other parts of these islands there is only a dense, tropical scrub, much like that of the Bahamas. The floor is of the sharpest, most irregular limestone with almost no soil. Gumbo limbo

(Bursera); wild tamarind (Lysiloma); *Trema floridana;* cat's claw (Pithecolobium); poison tree (Metopium), and a few other low trees constitute the main scrub. On the Upper Keys there are acres of stunted century plants, often growing so densely that it is impossible to get through; with them are several kinds of Opuntias or prickly pears and the terrible *Cereus pentagonus* which sprawls over all. In lower ground a Bumelia (*B. angustifolia*), usually a dense shrub, has narrow leaves and vicious thorns. A half vine (Amerimnon) almost fills solid the spaces in which it grows. One could no more force his way through a haystack than through a patch of this shrub. And everywhere the whole is literally bound together by the pull-and-haul-back (Pisonia), the vilest thorny shrub in Florida.

The breeze is almost entirely shut out of this dense scrub; usually millions of mosquitoes and sand flies torture anyone entering it during the warmer part of the year, and sometimes even in the winter. I have had a good deal of experience as a naturalist collector in temperate, subtropical, and tropical regions and I am ready to go on record with the statement that the wilds of Lower



Getting out Plants of *Cereus deeringi* from Lower Matecumbe Key
Photo by Dr. John K. Small

Florida can furnish as much laceration and as many annoyances to the square inch as any place I have ever seen. When one has been at work on the keys or parts of the mainland for a week his body and limbs are filled with thorns of every description, and there is scarcely a spot on him that is not bitten by insects. A man who can endure all this and never lose his temper is fit to be a king; he can govern himself and he should be able to govern others.

On one occasion I undertook a trip alone, going by rail to Big Pine Key and tramping back from station to station, the most of these being mere flag stops. I searched the big island for the nearly extinct arboreal snail (*Liguus solidus*) with poor results, and then tried to get over to No Name Key, a mile away. I was told that a negro had a skiff and might carry me over if I hunted him up. His name is Joseph Sears, a powerful man in the prime of life. His shirt and trousers were full of holes but such a magnificent physique was a goodly sight to behold. When I asked him if he could take me to No Name he looked doubtfully at the weather and shook his head. A very strong wind had been blowing from the north-

east for several days and the sea was exceedingly rough.

"I doan' know, sah," he said, "dis mighty bad win', an' dar'll be a big sea in de channel. I doubt if I can put yo acrass, sah."

I told him I was very anxious to go and again he surveyed the weather. "If dere's any mans in dis islan' can put yo 'crass it's Joséf"—the accent on the last syllable—"but yo got no idee how rough it is in dat channel." I strongly urged him to make an attempt, and at last after scratching his head several times and telling me that No Name was full of rattlesnakes he said:

"I try it, boss, but I tell yo one t'ing, if I put yo 'crass yo got to pay me mighty well foh it."

I had only money enough reasonably to carry me through the trip, and as I thought that "Joséf" intended to make me pay an exorbitant price I very reluctantly concluded to give up going. However, I plucked up sufficient courage to ask how much.

"Hit'll take de bes' paht of a day, boss, an' I bleedzed to chahge yo dollah an' a half."

As soon as I could recover from my astonishment at his exorbitant figure I told him we would go.

His fine, strong boat, the "Three Fannys," he hauled into the water and got me aboard. Before he could ship the oars she had drifted quite a distance to the leeward, such was the force of the wind. It blew across from No Name Key, a full mile away, and the sea was covered with white caps. For a long time "Joséf" made scarcely any headway, gaining a little when the wind lulled and dropping back when it blew harder. I encouraged him, but he said: "Dis nottin'; wait till yo get in de channel, den she shake yo up."

Sure enough, we did get shaken up when we got to the channel. He expended all this splendid strength in trying to drive the boat ahead as he continually shouted to the sea and his skiff. "W'at yo mean comin' heah dis away?" "Keep off fum heah an' lemme 'lone." "Stan' up to her ole gal an' doan' let her knock yo out." Whenever a big sea struck us he gave vent to a whoop that could have been heard to No Name.

Little by little he worked across the channel, but when nearly across a heavy sea struck us and knocked the port oar and rowlock out. The boat fell off broadside to the sea and for a minute I was sure we would capsize. I got the rowlock in place

and climbed up on the weather gunwale, but in a short time he had the oar in place and brought the head of the boat into the wind.

"Man, suh," he said, "ef dat boat capsize we drif' out into de Gu'f Stream an' de shahks sure get us!"

Across the channel the water became smoother and we soon landed at an old wharf. "Joséf" took me to a fine hammock and helped me search for tree snails, but we found only a few dead ones. He told me he had helped to cut down a lot of the original forest several years before.

"Man," said he, "I could a-got yo a hatful ob dem snail den!"

Towards evening of another day I tramped into the little village of Vaca or "Conch Town," a settlement of Bahama negroes, where I tried in vain to get a bed and food; no one would let me sleep indoors but at last I got permission to occupy a ramshackle outhouse. I hurriedly put up my mosquito bar and as I had no supper I rolled up in my blanket and tried to fit my body to the irregular, rocky floor. Notwithstanding the fact that the night was cold the mosquitoes were bad. I soon became completely chilled. The dogs be-

longing to the family having a better title to the shanty came in to occupy it with me. In order to get warm they huddled close to me and tore down my bar, letting in the mosquitoes. I got up and undertook to walk about in order to warm myself, but on account of the irregular rocky floor and the darkness I was in danger of falling, so I went back to my flea-bitten dogs. Later a train came rushing along not far away and I made my way out and walked up and down the track until after an age, as it seemed to me, I saw the first streaks of the blessed dawn.

In the morning I got a few cooked black beans from the proprietor of my hotel and started north along the track, collecting and studying geology. That evening I arrived at another flag station and applied at a fairly decent-looking house for lodging and supper. It was evident that the woman who came to the door did not welcome me, and when I told her I wasn't a tramp, but a wandering naturalist, she said: "O, they all 'as some fine hexcuse; there was one 'ere the other day as said 'e was a doctor, but 'e was nothing but a tramp, an' 'e was better dressed than you." Then I went out to the railroad and looked myself over.

I wore a tolerably whole suit of khaki, not too clean, however, for I had lately gone through a freshly burnt district and I was covered with black marks. My coat and wool hat were torn by "pull-and-haul-back" vines and my strong leather shoes were literally cut to pieces by the sharp rocks, so that I had been compelled to tie them on to my lacerated feet with old pieces of cloth. If anything else was lacking in my make-up to prove that I was a genuine knight of the road, the two-quart water can which I carried completed the evidence. So I "'unted up a hempty 'ouse" as the woman had suggested, put up my bar, made a bed of grass, and as the weather had moderated, I slept royally. The next afternoon I flagged the train and arrived home after dark, having been thirty-eight hours without food.

The waters of the key region are exceedingly shallow, the bottom either being composed of ragged rock or very soft, almost fathomless mud. Navigation chiefly consists in getting aground and getting afloat again. One never makes an extended cruise among the keys without getting "piled up" as it is called, often several times a

The *Barbee* Exploring Boat Belonging to Chas. Deering near Lower Matecumbe Key with a Load of Cacti
Photo by Dr. John K. Small

day, and strangely enough this generally seems to occur when the tide is falling. If the boat gets on the rock bottom one is fortunate if it is not seriously injured; if it gets fast in the mud there is pretty sure to be an amazing amount of trouble getting afloat. In the former case everybody must get overboard and try to lift the boat out of the grip of the ragged rock. If the vessel is fast in the mud poles will do little good as they can usually be pushed to full length into the soft marl. The engine is reversed, all must get out, sometimes sinking in to the waist, and lift until they can see stars. Often the boat is delayed for hours.

The greater part of Big Pine, Little Pine, a part of No Name, and one or two other keys of the lower chain are covered with an open forest of the common Caribbean pine of the lower mainland, interspersed with one or two Thrinax palms, but only a few pines are found on the Upper Keys. The surface of the Lower Keys is largely plate rock, far less ragged than that of the upper chain of islands. This and the fact that the former are almost free from the sharp pointed, dwarf Agave and entirely so from the dreadfully spiny

sprawling Cereus make it much easier to get about them.

Notwithstanding the fact that the forests of these islands bristle with a great variety of thorns; in spite of the stifling heat within them; the uneven rocky floor; the difficult navigation, and the hosts of tormenting insects, the Florida Keys possess many charms and allurements to the lover of nature, or to the observant, intelligent tourist. There are over 600 species of flowering plants known to inhabit these islands and a large variety of interesting birds. The entomologist finds here a rich field and the reefs swarm with varied and vividly colored life. Many of the beaches are composed of gleaming white coral sand and everywhere there is the intense glow of the sunlight which is characteristic of the tropics. There is often a peculiar shimmer of the dazzling light in which distant islands are lifted up mirage-like into the atmosphere, even until their connection with the earth seems severed. The various tintings of the sea from pale to deep green and through almost every shade of blue are entrancing.

Finally the Florida Keys are the only bit of the real tropics within the limits of the United States.

Yucca aloifolia (Spanish bayonet)
Photo by Dr. John K. Small

CHAPTER III

The Ten Thousand Islands

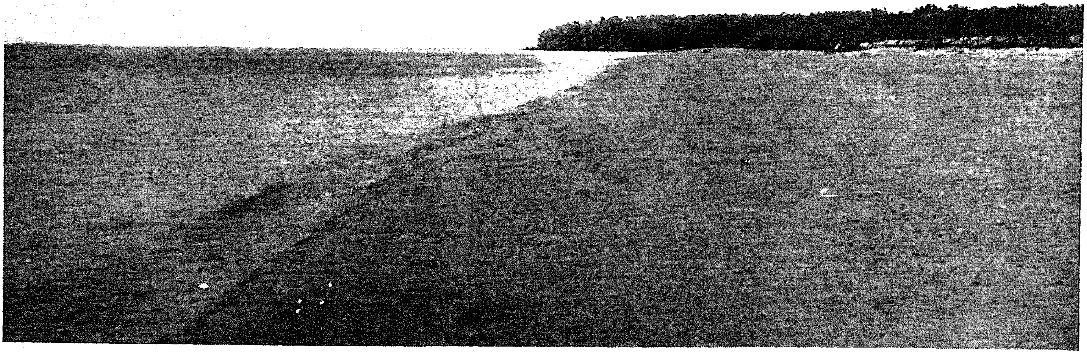
TEN THOUSAND ISLANDS,—the very name savors of mystery, of the joys of exploration and discovery.

Beginning just south of Naples on the southwest coast of Florida this archipelago extends southeast in an unbroken curve to Northwest Cape Sable its concave side towards the sea. Those most familiar with the region say the group of islands has an average width of eight to ten miles. The entire region consists of a myriad of low islands, covered with tall, slender, closely set mangroves having but few buttressed roots, with here and there, some black mangrove, buttonwood, white mangrove, and a few other swamp-loving trees. Along the sea front and for some distance inland the islands are separated by channels of varying width and often of considerable depth. Through these the tides sweep strongly, dissolving

and scouring out their rocky bottoms. These passages are drains for the surplus water of the Everglades and of the low lands back of the archipelago.

As one penetrates the group towards the mainland these tideways become shallower and narrower; the low-lying land rises very slightly and occasional saw palmettos and cabbage palms appear. *Ficus aurea*, *Ilex cassine*, and wax myrtle are soon after met and finally, still farther on, are low prairies with scattered pine and cypress. So the Ten Thousand Islands gradually merge into the mainland like a dissolving film change and it is difficult to say just where one ends or the other begins.

I am told by those who know that there is no natural land in the entire region which rises above the level of an extremely high tide. I have been over much of it and my observation confirms the statement. Just north of Cape Sable for seven or eight miles fronting the open sea, the dense lofty mangrove forest stands like a solid green wall seventy or eighty feet high. The Gulf of Mexico bathes the roots of this wonderful growth and although its great swells roll in against them over an open reach of a thousand miles they do



Giant Mangrove Wall Facing the Gulf of Mexico just North of Cape Sable. Open Sea Stretching for a Thousand Miles Lies to the Westward of this Forest and Constantly Beats Against it

Photo by Dr. John K. Small

but little harm. But few dead or fallen trees are ever seen, though in westerly storms the sea must assault them with terrific fury. This lofty, sullen forest, opposing in gloomy grandeur the open ocean and ever defying its force, is one of the most awe-inspiring sights in Florida.

North of this forest wall is a deep bay or indentation of the shore nearly three miles across and extending about two miles inland; there begin the numerous islands of the Shark River Archipelago,—really a part of the Ten Thousand Islands. It, too, is a maze of islands, channels, lagoons, mud flats, and low, wet prairies and forests, the latter of mangrove and other littoral vegetation. The water varies from salt to brackish, though in places it is actually fresh, the salinity depending on the season and rains. A vast amount of Everglades drainage passes through the Shark River Archipelago. This island labyrinth extends to the east and southeast for twenty miles, even penetrating the region back of the slightly elevated prairie east of Cape Sable. In fact it nearly reaches the south coast, where it is generally known as White Water Bay. There are several open bodies of water within this area

which have received names,—such as Coot Bay, Bear Lake, and Mud Hole Lake, the last name being especially appropriate and equally applicable to all. The whole region is incorrectly represented on our maps. Obviously it is an amazingly difficult and complicated territory to survey, but the need of it is not very pressing.

The Coast and Geodetic Survey have merely outlined the edges of the islands which face the Gulf of Mexico. Natives of the region no doubt have extensively explored the archipelago but it is probable that many of the islands have never been visited by white man. The Seminole Indians pass through in their dugouts to and from their camps on the mainland but I do not think that any of them actually live in the region. They have occasional camps in the low pine woods which alternate with cypress swamps, ("strands" as they are called) on the borderland.

Several of the outlying isles facing the sea have sandy beaches as is the case along most of the Florida west coast. In some places, notably outside of Lostmans Key or island, there is a wide area of sand washed up by the surf. The name, by the way, of this island is in dispute, some

setting forth the claims of one Mr. Lossman and others preferring the legend of a man lost upon it. There is a hammock somewhere on Lostmans reported to harbor a colony of the large tree snails. I landed once for the purpose of stalking them. There were five in our party and evening being near, we separated and struck out for the interior, agreeing that the first to reach the hammock should shout for the others. From a sandy prairie I entered a dense, lofty forest of mangroves and Avicennias, not paying much attention to direction in my eagerness to find the hammock. Occasionally the floor of the swamp was somewhat open, probably because the forest was so dense that nothing could grow under it. In other spots the trees did not stand quite so close and young mangroves and other littoral vegetation grew thickly. It was a very dry time and the ground muck was fairly firm, making walking less difficult; though in places I sank at every step to my ankles. On account of the occasional thick undergrowth I could not maintain a straight course, but hurried on rapidly as possible toward what I supposed was the center of the island. Having tramped and floundered along for half a mile or more I noticed

that the sunlight no longer came from the west but from the northeast instead. I realized that I was lost in this gloomy forest with night just at hand.

My sense of orientation is so poor that the bow of a boat continues to point always in the same direction as when I got aboard. For some time I labored about without any idea of direction and finally resigned myself to the unhappy thought of a night in the swamp. Though the mosquitoes were not at their worst they were abundant enough to make sleep impossible, and moreover, they were increasing as the light faded. I tried to figure out where the shore should be but it was no use.

Losing oneself in a forest where the consequences are likely to be serious is most disquieting. The feeling that one's wits have deserted him, and the sense of lonely helplessness are most depressing. I searched my pockets for matches, and found instead a small forgotten compass. I knew the shore must lie to the southwest so violating my confused ideas of direction I followed the course the needle indicated. I pressed ahead excitedly and as fast as possible, now and then turning aside where the young growth was too dense to push through.

Chokoloskee Island, Ten Thousand Islands. The Island is Composed of Oyster and Other Shells Left by Prehistoric Man

Photo by Dr. John K. Small

Before long the forest was a little more open in front and a short distance farther I emerged at the very spot where I had crawled through into the swamp an hour before. The sun had set and as I hastened across the rolling sandy plain I saw our launch at anchor and the skiff on the beach. Some of our party were just coming out of the swamp, but none of them had found the hammock. I concluded that the name "Lostmans Key" was entirely appropriate.

Here and there among the Ten Thousand Islands are shell mounds, some of them of considerable size; indeed that on Chokoloskee Island is said to cover two hundred acres. I may remark in passing that like the geography of this region the spelling of all its names is very confusing. The name of this particular island is variously written; on some of the maps the island is spelled one way and the village another. There is a "Harney" or "Hurney" River; the same stream is called "Chokaliskee," "Chokaluskee," "Chokoloskee" and "Turners" River. On some maps a great arm of the sea, twenty miles wide and over thirty long, enters this region just north of Cape Sable and is called "Ponce de Leon Bay" and again

"White Water Bay." The entrance into this bay is in reality a narrow, brackish stream, or rather the two delta mouths, of Jos River and Big Sable Creek which open to the Gulf of Mexico through the great wall of mangrove forest. There is also a water connection to the north with the Shark River Archipelago. Chokoloskee Bay is sometimes represented as a large triangular sound and again as a mere constricted channel. On some maps it is not indicated at all.

The village of Chokoloskee is built on a great island shell mound in one place thirty-five feet high. At another spot on the top of a mound a space forty feet square is leveled off as if intended for a lookout or possibly for the site of a building. In places the shells are disposed in long parallel ricks, as though the Indians who placed them had begun the process at the shore and gradually moved inland. The shells forming these mounds are all of species now living in the Gulf of Mexico near by and are mostly the common oyster (*Ostrea virginica*); *Fulgur perversus*, a large, reversed shell; *F. pyrum*, *Fasciolaria gigantea*, the largest gastropod mollusk of the new world, *F. tulipa*, *F. distans*, *Melongena corona*, and *Murex pomum*. There are

"Home, Sweet Home." A Typical Palmetto Thatch House on Chokoloskee Island

Photo by Dr. John K. Small

also great numbers of the big clam, *Venus mortoni*, several species of the Macrocallistas, Tellinas, Lucinas, Dosinias, and other bivalve mollusk genera. Without doubt the flesh of all these were used for food by the aborigines formerly living here.

Who built these mounds; what kind of people were they; whence came they; how long did they remain; what has become of them? Were they of the same race that built the fresh-water shell mounds along the St. John's River in northern and central Florida and elsewhere north to New England? Did they drive out some still older race when they occupied this territory and has some later tribe conquered and exterminated them? What of their lives, their habits, and customs? The archæologist has examined their shell heaps and found where they made their fires, he has unearthed broken human bones,—were they cannibals? He has found entire human bones, sometimes laid out as if for burial. He has gathered many fragments of coarse pottery, sometimes plain, sometimes decorated, and he has compared them with pottery from distant mounds. He has taken from the shell heaps what

seem to be bone implements, some of them made for purposes that he cannot even guess.

There are other low mounds in this region made of earth with a slight admixture of shells. There are also long, straight canals cut through what are now mangrove forests, some of which contain water and are more or less navigable for canoes. Sometimes a layer of shells alternates with one of soil, as though the mound had been inhabited and built up for a certain time and then abandoned. Whether the same tribe returned after long absence or another came we do not know. In some of the mounds the pottery of the upper layers is of a finer quality and more artistically finished than that from below; this conveys the idea that the growth of the mound was of long duration; possibly that it had been inhabited by different tribes.

Jeffreys Wyman and Clarence B. Moore have made extensive investigations among the freshwater shell mounds of Florida and the latter has studied these same marine shell mounds, but only a beginning has really been made and results are meager. Even in Europe, where the remains of prehistoric man have been exhaustively studied, archæologists

differ fundamentally on many vital points, such as the duration of certain tribes, the time of their appearance and disappearance, and on many details concerning their lives.

Let us suppose that by some terrible catastrophe the entire population of the United States should be destroyed and the whole country left uninhabited for ages. Then, say, ten thousand years after this devastation some wandering archæologist should visit what was formerly Dade County, Florida. There would not be even the proverbial "two streaks of rust and a right of way" left of any railroad. In a hundred years all the ties, bridges, and wood of any kind would be crumbled into dust, and in a few centuries at most all the metal would be rusted out and scattered by the elements; the low cuts and embankments would be quite obliterated by rain and wind action. Down on the Key extension some remains of the concrete arches might be left and they would probably be taken for the ruins of an old aqueduct which had supplied water to some long lost city. Of Miami, the "concrete city," there would probably remain a few fragments of walls which had not yet been overthrown by time and

the hurricanes. Here and there would be found low, shapeless mounds overgrown with thick, tropical scrub. Should this scientific explorer proceed to excavate he might unearth a lower jaw of a white man and the skull of a low-type negro. He and other learned scientists would probably write profound papers on this wonderful find, putting the two together and wondering that a man with a low, retreating forehead should have such a high type of jaw. If the archæologist should dig down and find broken glass and ironstone chinaware, he would conclude that the Miamians had some knowledge of art, but should he happen to make his excavation in the back yard of a restaurant and unearth a quantity of oyster and clam shells he might be convinced that they were of a low type that subsisted on shellfish.

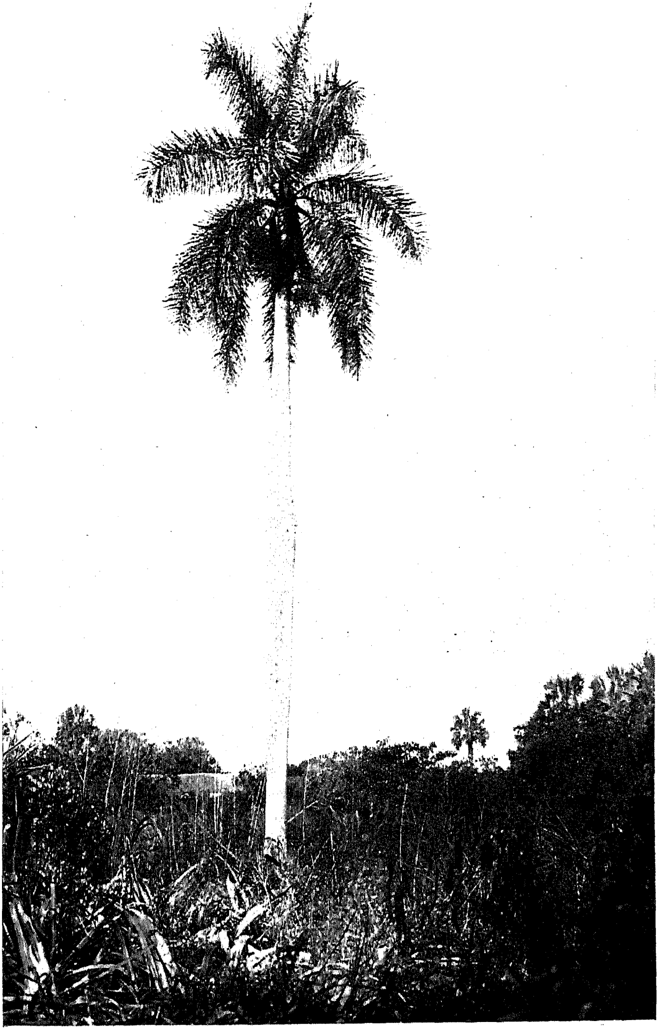
One bit of evidence furnishes a clue to the amount of time elapsed since these mound builders vanished, and it indicates that their departure took place a long time ago. As I have already said there is little or no natural land in the Ten Thousand Islands region that rises above an extreme high tide. This would indicate that

no real hammock developed before the advent of the mound builders. It is doubtful if any existed there even while they occupied the country. The people who lived there certainly created the shell mounds, the only possible places on which dry-land hammock could grow, and as they must have lived on these mounds after they built them it is more than likely the hammock growth only sprang up and covered the surface after their departure. It takes a long time for shells on the surface to disintegrate and form a soil, on which herbaceous vegetation can subsist. The gumbo limbo tree was, no doubt, a precursor of the hammock, as it will grow in very arid situations. After a little soil was formed, seeds of the hammock trees were borne in by the sea or brought by birds, and grew. I counted on Chokoloskee Island over thirty species of tropical trees and large shrubs, besides several warm temperate forms.

After the hammocks were established three species of arboreal snails appeared and became a part of their fauna. One of these is a Liguus (*L. fasciatus*) which is represented in the Ten Thousand Islands by two quite distinct sub-species; there is also the "black snail," a variant

of *Liguus crenatus* and then a large Oxystyla. All these grow only on the trees in the high hammocks and are found living to-day on the Upper Keys, having possibly originated on them and crossed over to the Cape Sable region by way of the old land bridge which I have elsewhere mentioned. From Cape Sable they appear to have reached the Ten Thousand Islands. I do not believe it was possible for these hammock-living arboreal snails to have inhabited these islands previous to the coming of these prehistoric peoples, nor, in all probability until after they vanished. It is quite probable that the Upper Keys were finished into essentially their present condition at the time of the second Pleistocene uplift and that these tree snails were developed, migrated to the mainland, and from there to the archipelago at about this time. If I am right in these surmises it seems quite probable that these aborigines are as old as the completed upper chain of keys and that they passed away while the present hammock fauna was migrating to the archipelago.

In his most readable book, *Florida Trails*, Winthrop Packard states that the royal palm is not a native of Florida. This is a mistake as it may



Native Royal Palm Growing at Rogers River, Ten Thousand Islands

Photo by Dr. John K. Small

be found growing wild in several localities in our State. When I came to Dade County seventeen fine specimens grew in a swamp just north of my home. At Paradise Key, in the lower Everglades, now a State park, over 2000 specimens, large and small, survive. It is said that a very tall royal grew in the vicinity of Cape Sable a useful landmark for seamen, but that it was cut down during the Civil War. This palm exists at several places on the south and southwest coasts of the State and also here in the Ten Thousand Islands southeast of Cape Romano. At the time I first visited this hammock in 1885 there were said to be 500 large trees and in addition there were great numbers of smaller ones.

The coconut has been called "A marvel of Titanic grace" and with equal propriety the "royal" as it is generally called here, might be styled a marvel of Titanic majesty. It attains a height of a hundred and twenty feet and sometimes even more, towering up, far above the tallest forest, where it spreads to the sun its regal crown of intensely deep green, glossy leaves. No other tree can be so appropriately called a king and as one gazes at it he may well appreciate

Kingsley's words: "It is a joy forever and a sight never to be forgotten." It is probably the most magnificent vegetable production in the world, and one of which all Floridians should be proud.

The Ten Thousand Islands is a region of mystery and loneliness; gloomy, monotonous, weird, and strange, yet possessing a decided fascination. To the casual stranger each and every part of the region looks exactly like all the rest; each islet and water passage seems but the counterpart of hundreds of others. Even those who long have lived within this region and are familiar with its tortuous channels often get lost. The chief native topic is of parties lost and wandering hopeless for days among its labyrinthine ways.

Head of Chokoloskee River in "Tommy Cypress," Ten Thousand Islands. Seminole Canoe

Photo by Dr. John K. Small

CHAPTER IV

Cape Sable

THE name Cape Sable,—cape of sand—is a somewhat improper designation for it includes three quite distinct capes, some distance apart, though the whole forms a decided projection of land into the sea. Northwest Cape is the northernmost point, then follow Middle Cape and finally East Cape, the latter the most prominent of the three; there are slight, open bays between them. The trio may be said to separate the Gulf of Mexico from the Strait of Florida. It is about ten miles from Northwest Cape to East Cape, and the latter has the distinction of being the southernmost point of the mainland of the United States. It extends about a half mile farther south than a slight projection just east of it and it is nearly fifty statute miles nearer the Equator than is the southern most tip of Texas.

From Northwest Cape to East Cape there is a continuous stretch of silicious sand which extends back from the beach a considerable distance. It stops abruptly at the edge of a great mangrove swamp. Farther inland is a series of brackish lakes and these lie more or less parallel with the sandy shore,—one of these is White Water Lake. Still farther inland and beyond both swamp and lakes lie rich prairies which, for the extreme end of Florida, are quite high.

In the lower Florida region making a landing is often a difficult matter. In some cases, especially along the keys, the beach consists of terribly ragged rock, often extending beyond the low tide mark. One is liable to get aground and injure his boat and once on the land walking is well nigh impossible. Usually near the shore the sea is very shallow and the bottom of soft, sticky mud. The explorer at times cannot get within many rods of such a beach, even with a light skiff, and he must get overboard and wade. Too often the shore is fringed with an almost impenetrable barrier of mangroves which may be a quarter of a mile wide. One must work in somehow to the edge of these, dragging his boat and making it

fast to the arching roots, then climb like an awkward monkey over and through the dreadful tangle to dry land. If a naturalist he likely has to carry bags for specimens, grub hoc, spade, ax, and camera, besides various other collecting outfit, some in his hands and more slung about him. The least slip means a fall into the water or among the sharp oysters attached to the roots. Often the growth is so dense and tall that the harassed explorer can only see a short distance in any direction and he can rarely find the sun owing to the dense foliage. So it is too easy to go wrong and even to describe a laborious circle back to the shore. If he does reach terra firma and complete his collections he can only guess on the way back where his skiff may be. He will likely crawl a long distance out to find the water,—but not the boat. It is better to blaze the trees going in and hope to be able to see the marks going out. At last he too often finds the tide fallen and he must wade again and drag the unwilling skiff,—seemingly miles.

But all is different at Sable. This beach is a paradise indeed for him who is fed up on the other sorts. Comparatively deep water comes in right

to the shore. One may anchor a boat drawing five feet hard upon the beach, and run his skiff directly on the sandy shore and step off dry shod. Dr. John K. Small, my companion on many collecting trips, has suggested that this deep water is caused by the strong currents which sweep by this headland, and I am sure he is right. Strangely enough there is a five-foot tide here though a short distance to the north (on the Gulf shore) it is hardly over a foot; it is even less in Florida Bay, to the eastward. Everywhere along this extended, uninterrupted beach the sand is firm and there are no mangroves. The country, for the most part, is covered with herbaceous growth or at most a low scrub for a considerable distance back from the shore, and it is exceedingly rich in interesting plants, nearly all derived from the American tropics. One has a glorious sense of freedom and comfort here which he experiences in but few localities in Lower Florida. Just to the southeast of East Cape there is safe anchorage against any ordinary storm.

This great sand bank is probably built over an old mangrove swamp for such a formation lies immediately behind and to the east of it. The

giant wall of mangroves which I have elsewhere described adjoins the northern part of Northwest Cape and the water along the entire sandy shore is so filled with sediment that it is unpleasant to bathe in it. This sediment, which is more or less mixed with coarser materials, seems to be chiefly the soil, peat, and half decayed wood from mangrove swamps.

This beach is a noted place for sea shells. During the time of storms when the wind blows landward, quantities of Murex, Fulgur, the Fasciolarias, handsome Olivas with their wonderfully zigzagged and tentlike color patterns, graceful cones, Cancellarias and Bullas among gastropods; Venus, Cardiums, Macrocallistas with delicately painted, polished shells, large Dosinias, as round as dollars, beautifully tinted Tellinas, among which the brilliant crimson *T. braziliana* is especially abundant; a large representation of the Lucinidæ and millions of Donax or "wedge" shells together with many other forms are strewn upon the littoral. The beach seems to be a sort of headquarters for the great "angel's wings" (*Pholas costatus*). This mollusk burrows to a depth of a couple of feet in the sand or mud and,

for this reason, is rarely found alive. But here the strong currents, no doubt, destroy the burrows and wash out the mollusk. Its beautiful detached valves, sometimes eight inches long, often lie on the beach in ricks. They are thin, peculiarly corrugated, and shaped somewhat like the wings of the angels in old pictures; this and their pure white color have suggested the name.

The Pholads, of which this species is fairly typical, are a large and diversified family, all of which are borers. Some of them, like the present species, dig only in sand or mud; others excavate their tunnels in wood or soft rock, and some bore out their nests in hard granite. For a long time the manner of their working was a mystery and by some it was believed that the boring was done by the edges of the rough, corrugated shells, but it is now known that this is not true. There is a set of strong muscles attached to winglike processes outside and at the back of the shell. These muscles can be powerfully contracted by the animal so that the two valves or shells are drawn wide open and their rough surfaces held very firmly against the walls of the burrow. With the shell thus held fast the animal turns and twists its large foot, which

is covered with sharp, siliceous spicules, first one way and then the other, and so laboriously drills out the material in which it lives. It is here I found a couple of specimens of the exceedingly rare *Cancellaria tenera*, the shell having flat, tabulated shoulders like a miniature stairway, but it is not especially beautiful.

Although nearly all the vegetation and most of the dry-land animal life of this region are tropical, derived in all probability, as I have elsewhere shown, from the Upper Keys over an old but now destroyed landway, the marine forms, on the contrary, are largely warm temperate or at most subtropical. This may at first seem strange but the explanation is simple. The tropical marine life of the keys has been brought to them by the Gulf Stream. But these very same keys and the plateau on which they rest, act as a barrier to the farther passage of this life to the Florida west coast. The water on the west coast of Florida is shallow for miles out from the shore and the Gulf Stream flows far to the westward. This wide belt of shallow sea often becomes quite cold in winter, especially in time of severe northers, and is therefore decidedly unfavorable for strictly

tropical marine life. For this reason only the hardier West Indian species are found here. Finally, as I shall show in another chapter, the marine life of the Gulf of Mexico was partly derived from the cooler part of the Atlantic, having migrated around the southern end of the Florida peninsula when it did not extend nearly so far south as it does at present, probably before the keys were formed.

I have said that this splendid beach is a paradise for the naturalist and collector. He may wander along it in perfect comfort, provided mosquitoes and sand flies are not too troublesome. Some distance back from the beach there is prairie with scattered scrub. As soon as one reaches this his troubles really begin. Over most of it a variety of low thorny bushes and creepers makes any progress most difficult, or even impossible. One is continually forced to turn back and seek another passage. In places the "poor man's plaster" (*Mentzilia floridana*) completely covers the ground and sprawls over the scrub. It has rather attractive yellow flowers but the stems and under sides of the lobed, deltoid leaves are thickly covered with barbed, glandular hairs.

Any animal or person coming among these plants soon becomes covered not only with the leaves but with their brittle stems. Sometimes the entire plant will catch hold in the most diabolical manner and break off. Other stems attach themselves to those which are already being borne away by the intruder, and if one is compelled to be among them for some time the result may easily be imagined. In such plight one is reminded of that delightful rascal, "Brer Rabbit," who spilled "Brer Bar's" bucket of honey over himself and was obliged to roll among "de leafs and trash" in vain effort to clean himself. The stems may be pulled off but it is utterly impossible to scrape the leaves from one's clothing. They cling to the victim's garments as dirty, greenish patches until they finally wear off. When well covered with the miserable things one is certainly, as Uncle Remus remarked about "Brer Rabbit," "De mos' owdashus-lookin' creetur w'at you ever sot eyes on," and one certainly looks like "de gran'daddy er all de booggers."

For a long time I could not understand why the leaves and stems of this plant attach themselves

so tenaciously to any object with which they come in contact. Some of the members of the same family to which the Mentzilia belongs are provided with stinging hairs which serve to keep the plants from being molested, but the hairs of this species do not sting. They are intended merely to catch and hold on to whatever touches them. Fortunately a plant of this species came up in my yard one spring and grew with great vigor during the entire season, finally covering a space twenty feet square, scrambling over other vegetation and up the lattice of my piazza. In the fall it bloomed and seeded profusely, thus giving me an excellent opportunity to observe and study it. I thought it possible that the branches when dropped might throw out roots and form new plants as do those of certain Cacti. I tore off a number and scattered them in all kinds of situations, even putting a few in my slat-covered plant house, but all withered and died.

The club-shaped seed vessels are covered with barbed prickles and filled with pulp containing a half dozen rather large, singular-looking seeds. These are black and rough, somewhat elongated and flattened, with two encircling ridges having

Thrinax wendlandiana, One of Florida's New Palms. Cape Sable
Photo by Dr. John K. Small

a groove between. They suggest in shape an Indian stone ax. The berrylike fruit does not open but remains attached to the plant long after it is ripe; finally decaying and allowing the seeds to fall. It is evident that the barbed hairs of the plant have two functions; they cling to the vegetation over which the Mentzilia sprawls, aiding it in climbing and holding on; when in fruit they attach the leaves and stems so firmly to the passer-by that much of the plant along with its load of seed vessels is torn off and thus carried to a distance. It is its method of dispersal. The long period during which the ripe seed is contained in the pericarp increases the chances of a carrier. The large seeds have sufficient vitality to sprout and grow vigorously among the dense vegetation of the locality in which the Mentzilia is sure to live. All in all, it is one of the most remarkable plants of our flora.

Formerly there were extensive hammocks at the capes, now mostly cut off and the sandy ground has been planted to coconuts. The beautiful silver palm (*Coccothrinax jucunda*) and another (*Thrinax floridana*) were once abundant, though it is probable that they no longer exist on the main-

land. *Thrinax wendlandiana*, another fine palm, supposed until recently to belong only to Cuba, grows in the cape region, along the south shore of the State, and also on the keys. Wild cinnamon (*Canella winteriana*), saffron plum (*Bumelia angustifolia*), wild dilly (*Mimusops emarginata*), and a number of other trees and plants belonging to the keys are found here, immigrants over the old mainland route to Metacumbe.

What remains of the cape hammock is not lofty but it is exceedingly dense and filled as full of thorny growth as is any other hammock in the State. Of this thorny growth the chief plant is a sprawling Cereus which I have abused elsewhere but it is sufficiently villainous to call for more condemnation. It is *Cereus pentagonus*. I cannot conceive how it would be possible to devise a more devilish plant. It starts in life by growing erect, but tiring of that it falls over and rests on other vegetation, or perhaps slides off and fastens itself to the ground from which it may spring up a second time. Not infrequently it almost fills all the vacant space in the forest, thrusting its long, lithē stems through the thickest growth and appearing in the most unexpected places. Its

Cereus pentagonus Filling All the Spaces in the Hammock

Photo by Dr. John K. Small

stems may be three, four, or five angled (the young ones sometimes have even more) and each angle is lined with terrific spines an inch or more in length. They are so sharp and strong that they easily pierce the heaviest leather boot. The explorer may be ever so alert but he is certain to run into it dozens of times in such a forest. He is equally sure to carry away a fine collection of its thorns, which have a vicious way of breaking off in his body. As though this were not enough there is another Cereus which is just about as villainous (*C. eriophorus*). It has about ten ribs and nearly round stems. Fortunately it has one merit that the other does not possess and that is it is rather scarce. In much of the cape territory a dwarfed form of Agave (common on the keys) covers the ground, and it frequently grows in company with a very spiny Opuntia. A more or less ever-present pest among thorns is our familiar pull-and-haul-back vine. The only relief from the grasp of its curved spines, after the preliminary resort to profanity, is carefully to cut away the entwining vines with an always handy and sharp knife. During the process one must not move an inch in any direction. Everywhere is a network

of vines—"invisible wires" as Kingsley calls them—to trip and occasionally throw one headlong among the merciless thorns. These "wires" belong to a number of species of Smilax, all of which are more or less thorny; a Mikania, related to the sunflower family; a Philbertella or Metastelma, which are really milkweeds; one species of grape and a common morning-glory (*Ipomœa cathartica*), which latter is always abundant in the thickets. The Ipomæa has no spines but its soft stems hang in festoons, or lying along the ground are drawn across the paths as taut as bowlines to catch the unwary. It flaunts its gay blue and purple flowers everywhere and seems to take a fiendish delight in tripping and throwing all who defy it by venturing into the scrub.

Formerly the hammocks at the capes were full of beautiful tree snails,—the large Oxystyla and two species of Liguus, but to-day very few are left. Among this remnant, however, there are some anomalies of distribution difficult to understand. *Liguus fasciatus*, represented by several varieties, is found at Middle and East capes but not at Northwest Cape, but five miles distant. At the latter locality it is replaced by *Liguus*

Cereus eriophorus, a Villainous Cactus of Lower Florida

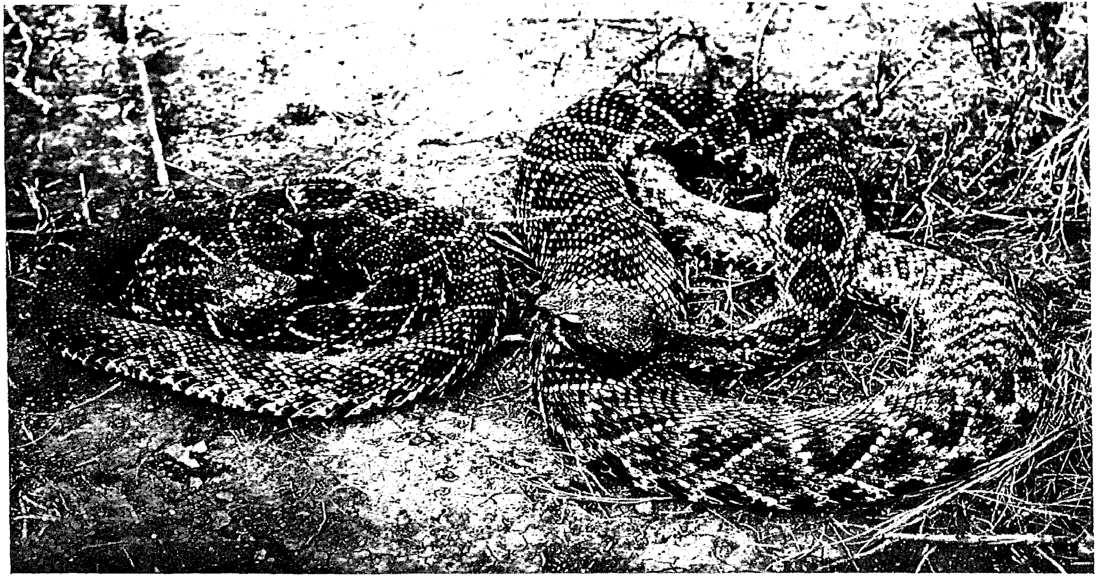
Photo by Dr. John K. Small

crenatus, so nearly like the Cuban form of the species that an expert could not separate them. The latter species is also found at Flamingo and again near Coot Bay and its adjacent hammocks, but from some of these the shells have a different marking. The peculiar "black snail" occurs on Key Vaca, at Middle Cape and Chokoloskee but has not, so far as I know, been obtained in any other localities. Usually only a single species or subspecies of Liguus is found in any of these hammocks, but why all other forms but one are excluded we do not know.

I had been warned repeatedly that anyone who explored the Cape Sable or south shore regions hazarded his life by reason of many rattlesnakes. My warning included many of the keys which were supposedly infested with them. In many years of cruising and tramping over the lower part of the State I had never met a living rattler or even a water moccasin, and I had concluded that the snake stories were largely myths. In the late autumn of 1916, in company with Dr. Small and my neighbors Victor Soar and Paul Matthaus, I visited the Cape Sable region, tramping from Flamingo to the cape across the interior prairie.

We had turned from the trail to enter a little hammock in our search for plants and snails. I was leading with Soar following when I heard a slight disturbance behind; turning around I saw him in the act of cutting off the head of a good sized diamond rattlesnake with his machete. He said I had stepped with my left foot close to its head and neck, then directly over its body, first with the right and then with the left foot. He had had the rare presence of mind not to cry out, for had he done so it is probable that I would have confusedly stopped and been bitten. Within ten feet he encountered another rattlesnake which was much larger, and killed it.

Returning from the cape soon after, we visited a small hammock near the scene of our morning's adventure. Our dog began barking furiously near by and then a snake rattled clear and strong. I called the two other men and began a search for the reptile, but the dog, on which we relied for help, became frightened and departed yelping. The hammock just there had lately been burned off and had grown up very thickly with rank weeds. After beating about for awhile without success we concluded further search in a dense



Two Diamond Rattlesnakes Killed in Hammock Back of Cape Sable

Photo by Dr. John K. Small

thicket too risky and reluctantly gave it up. The next day the Doctor found a very large, freshly-shed rattler skin at the cape. Some people we met there told us never had rattlers been so abundant; they were killing them every day.

In his delightful book, *The Naturalist in La Plata*, Hudson tells of a "wave of life" and says: "Turning back to 1872–3, I find in my note book for that season a history of one of those waves of life—for I can think of no better name for the phenomenon in question—that are of such frequent occurrence in thinly settled regions. . . . An exceptionally bounteous season, the accidental mitigation of a check, or other favorable circumstance, often causes an increase so sudden and inordinate of small, prolific species, that when we actually witness it we are no longer surprised at the notion prevalent amongst the common people, that mice, frogs, crickets, etc., are occasionally rained down from the clouds." He proceeds to tell how, that same year, owing to favorable conditions, the country was overrun with a variety of the smaller wild animals, bumblebees, mice, storks, owls, and other things; that later when the

environment became unfavorable this superabundance of life melted away and the old order was restored. I believe that a wave of rattlesnake life must have occurred in the vicinity of Cape Sable.

It seems a strange thing that so few are bitten by rattlesnakes and I can only conclude that they rarely if ever strike unless actually provoked. I have known of a number of cases of snakes almost stepped on that refrained from attacking. Nothing in nature can be more hideous and terrifying in appearance than a large diamond rattlesnake, or more perfectly fitted to demoralize a courageous foe.

We had planned to visit several places after leaving Sable, but at the next stop with the anchor over no one seemed to manifest any disposition to go ashore. It was agreed that the tide was too low to land, so we up anchor and proceeded on to Jo Kemp's Key. We did land there and talked with some fishermen, who confirmed the snake stories we had recently heard. They admitted they hardly dared step outside the paths. The Doctor, who wore heavy, high leggins, took a brief turn along the edge of the hammock but

didn't venture into it. He soon came back to the boat and remarked that there wasn't anything of interest on the island anyhow. Then we went to a point on the mainland northeast of Jo Kemp's Key and pottered about the open ground near shore, but all seemed nervous and nobody ventured into the scrub. After a brief consultation we decided to start for home. Small claimed he had gotten about all the plants he had expected to find. Of course it was ridiculous to suppose that any of us were afraid of snakes or that there were not the most urgent of reasons for going home. The urgency of the reasons is well expressed in a popular song of a few years ago entitled: "'Tain't no disgrace to run when yo' are skeered."

At the time of my last visit to the capes we saw, upon nearing the shore, a solitary man sitting on a log. I talked with him while the rest of our party were busy botanizing. He was powerfully built, of middle age, and decidedly intelligent. He informed me he was the keeper of the big coconut plantation along the shore. I was curious to know why he had chosen to live in this lonely place and questioned him accordingly. He said his

home was in Ohio and that for many years he had suffered greatly from rheumatism, becoming finally so disabled that he could scarcely get about. Then he determined to come to Florida and seek relief in a gentler climate. He had to be carried aboard the train and to rely upon the kindness of chance acquaintances to help him on and off when he had to change cars. He stopped for awhile at St. Petersburg and, feeling better, accepted a position as keeper of this coconut grove. Asked if he didn't find it very lonely,—for his nearest neighbors at Flamingo were fully ten miles away,—he said, "Yes, it is lonesome, and I have a hard time getting along without anything to read, but I had rather be in this wilderness alone and *well* than at home with all my friends and sick." And he stood erect and walked about very firmly and proudly to show how completely he was cured. Verily there is no richer possession than health!

Cape Sable is indeed a wild, lonely place. From north around by west to the south is the uninterrupted ocean horizon; to the southeast a few little islets break the monotony of an open sea, mere dots that they are in a wide expanse of water. Back of the gleaming beach is a somber forest and

a dreary swamp. Formerly there were two or three houses on the cape but the last hurricane destroyed them. During such storms when the wind is westerly the beach is fully exposed and the sea with a thousand miles' sweep sometimes rolls clear over the capes and inundates the entire area.

CHAPTER V

The South Shore of the Mainland

A CONSIDERABLE part of the mainland south shore of Florida and of the region for some distance back from it into the interior is almost a *terra incognita*. There are a few houses at the little settlement of Flamingo on the shore seven or eight miles from East Cape Sable; the balance of the area is an uninhabited wilderness. Along most of the shore line there is a fringe of tall mangroves, and in the vicinity of Cuthbert Lake this growth extends for several miles inland. A series of rather low hammocks borders the sea for some distance and back of these are buttonwood swamps. There are two or three abandoned shacks on this hammock land and occasionally one sees a schooner loading buttonwood for fuel for the Key West market,—these being the only signs of human life one ever meets in this lonely region.

At the time of this writing one could cross the State from Northwest Cape Sable to Chis Cut on lower Biscayne Bay, a distance of fifty-five miles, without seeing a house.

The entire territory is very flat and probably no part of it rises more than four feet above high tide. From Cape Sable to Card Sound the whole region is overflowed during hurricanes from the west or southwest, and driftwood is then washed up among the trees to a height of four or five feet above ground.

The shore line is exceedingly irregular, although not so hopelessly complicated as in the White-water Bay region. A number of rather large bays enter from the south, some with narrow necks, while long, bootlike projections of land reach far out into the sea.

The vegetation of the hammocks is almost entirely tropical, being nearly identical with that of the Cape Sable country. Mahogany, Joe-wood, wild dilly, mastic, and wild cinnamon are characteristic, the latter being a beautiful tree with rich, dark green, shining leaves which have a decidedly peppery taste. One is constantly being led into chewing them for their flavor of

cinnamon and getting his mouth well burnt. In a few places the stately royal palm is found growing luxuriantly, and in some of the more inaccessible swamps there are quantities of a Cuban palm, *Acœlorraphe wrightii*, confined in the United States to this restricted south shore region. It has fan-shaped leaves and slender stems which reach a height of thirty feet, the whole growing in dense masses possibly fifty feet across. It is as light and graceful as a bamboo and is one of the finest ornamentals of Florida. The common cabbage palmetto (*Sabal palmetto*) is abundant, probably the only tree in the region that is not tropical. The sheathing bases of its leaves enclose the young growing trunk, and when the latter attains full size the sheathings are split open. The blades of the old leaves fall, leaving the remainder attached to the tree, sometimes twenty feet high. These old leaf bases are commonly called "boots," and while they remain they add greatly to the picturesqueness of the tree. One is sure to find a small botanical garden among these boots, for they provide shelter and an ideal place for the attachment of epiphytes. Around the leaf bases is a thick and strong network of fiber

Cabbage Palmettos near Punta Gorda, Florida

which binds and supports the young leaves, and when this begins to decay it makes an admirable bed for the roots of many plants and also a very comfortable home for many kinds of insects. A dozen species of ferns and an equal number of air pines may take lodgment on these young palmettos. The serpent fern (Phlebodium) and two species of sword fern (Nephrolepis) commonly attach themselves among the dead bases of the palm leaves—just under the crown of living ones, and the fronds of one of them often hang down a couple of yards. The seeds of the strangling fig often lodge and grow among the boots, eventually destroying their kindly host. Several orchids also flourish in this little air garden, especially the pretty *Epidendrum tampense*.

If the young palmetto is a botanical garden it may with equal propriety be called a zoölogical park. The shelter afforded, the decaying vegetation, and the wealth of plant life about the boots combine to make the tree an ideal spot for a menagerie of small life. Tear off a boot and a swarm of great brown ants is sure to rush out and attack the despoiler, biting severely; they may be accompanied by a minute black species whose bite

is even more painful. In such station one will find many beetles and an occasional myriopod. If not watchful one is likely to be stung by a scorpion. There is almost certain to be a specimen or two of the hideous vinagerone or whip scorpion (*Thelyphonus giganteus*);—"scruncher" as it is called by the natives. It is two and a half inches long, of a lurid, dark brown color, with two immense palpi or nippers, a long rounded abdomen, ending in an extended lashlike telson. No regular scorpion presents so dreadful an appearance and it is little wonder it is so feared. Many insist that its sting is fatal. An old darkey of the Uncle Remus type whom I knew lived in constant terror of them. "Man, suh," he once said, "dat's de mos' owdashus beas' in de whole worl', an' ef ever he hit yo a lick wid dat tail o' his'n yo shuah 'nuff a goner." Notwithstanding the fact that Blatchley and other naturalists declare that this Arachnid is absolutely harmless I prefer to let someone else examine it. A great wingless cockroach with a very strong odor (*Eurycotes ingens?*) is generally abundant, and a curious Arachnid of a dark brown color, resembling a small crab, is occasionally seen. The red-headed lizard (*Eu-*

meces fasciatus) darts rapidly about in search of insects. When young his tail is blue; when old this color fades and his head becomes red. Another reptilian member of this miniature zoo is a handsome green "chameleon" (*Anolis carolinensis*) which leaps and scurries about among the boots. Several spiders spin their webs in the palmetto, attracted by the harvest of insects. One of the wood rats, probably *Rattus alexandrinus* (an importation from North Africa), sometimes makes its nest in the great leafy crown or among the associated vines and rubbish. A very slender and beautiful green snake (*Leptophys?*) glides swiftly and securely among the tangled mass of greenery and a much larger brownish one sometimes stares at one from his home in the tree top.

When the palmetto blooms there assembles about it a convention of flying, honey-loving insects, butterflies, moths, wasps, hornets, and bees, all eager to share in the crop of luscious honey or in some cases to prey upon each other. This insect gathering brings many birds to feed upon them. Among the honey seekers there may be one or two species of a slender-winged insect of a deep, steely blue with white spots and with a

rather swollen abdomen. I long took them for wasps and no doubt the birds are so deceived. On closer examination they prove to be diurnal moths, belonging, perhaps, to the family Ægeridæ. They are among the most attractive insects of Lower Florida. We certainly have no other tree that is the home and resort of such a wealth of life as is the cabbage palmetto.

At some distance south of the mainland is the chain of Florida keys which gradually approaches as it bends to the northward and between the two lies the Bay of Florida. The bay is studded with low, mangrove-covered islets, and over many square miles the tide scarcely ebbs and flows. When an easterly wind blows strongly much of the bottom may be uncovered even for days at a time. Everywhere along the mainland shore and for some distance out the bottom is of an impalpable white marl resting on a foundation of limestone a few feet below. It is certainly the softest and stickiest stuff in the whole world. It varies in its consistency from milk to a thick paste.

In times of storm this white mud is stirred up from the bottom and mixes with the water until the whole is a sort of dirty greenish white, often

retaining this color for days. Drew has found in tropical waters denitrifying bacteria that in their life economy transform certain soluble calcium salts to the insoluble calcium carbonates, precipitating the latter in the form of minute granules. These bacteria are especially abundant in the Bahaman and South Floridian waters. This is partially the cause of much of the milkiness of the water of this region and accounts for the origin of the soft oolitic mud found throughout Hawk Channel and all our shallow bays. Year in and year out these bacteria are changing a part of the liquid sea water into a solid which is being added to the land. All the hammocks along the south shore have this marl for a foundation; their upper soil being only a thin layer of mold. It is refreshing to find a new bacteria that does good instead of evil.

Several years ago I visited Flamingo in November for the purpose of making natural history collections. The edge of a hurricane had passed over the region shortly before and, with the exception of the higher hammocks, the country was covered with water,—in places to the depth of two feet. We had several partly cloudy, showery days and the mosquitoes swarmed everywhere to

an extent that I have never seen before or since. In company with a Mr. Roberts, long a resident of the south shore, and two other men staying at Flamingo, our party started afoot for Coot Bay, an arm of White Water Bay, about six miles inland. We passed through low inundated prairies and hammocks with here and there a higher spot cleared and planted in sugar cane. The soil is wonderfully rich and where the cane had not been killed by the overflow it was rank and fine.

In one of the hammocks we found the papaw (*Carica papaya*) growing abundantly as an undergrowth in the tall forest. I have never seen it so fine and vigorous, even in the tropics. The plants have perfectly straight trunks, smooth in the lower part, often as large as a man's body and fully twenty feet high. For a space of several feet the upper part of the stem is clothed with leaves, these having straight petioles three or four feet long which, after shedding, leave peculiar ornamental scars on the trunk. The great palmate blades are more than three feet across, forming a beautiful crown extending well down the tree. At the bases of the petioles were the yellow flowers The tree is diœcious in most cases and the male

blossoms are borne on slender, branching stems while the larger female flowers are nearly sessile. The latter develop into roundish fruits a couple of inches in diameter which are crowded on the stem for several feet. The outer part of the trunk has considerable fiber but within this is merely hardened pulp. The stem is ordinarily unbranched, but if the growing bud is injured it sometimes divides into two or more limbs. In a wild state the fruit is small and insipid but when cultivated and carefully selected it becomes at times as large as a muskmelon and of delicious flavor. Sometimes male trees produce peculiar, slender fruits the seeds of which are fertile. Wild or cultivated the tree is one of the most beautiful and striking objects of the tropics. It grows in Floridâ from the Indian River on the east and Tampa Bay on the west to the extreme lower part of the State. Bartram tells of his joy and astonishment at seeing this tree growing wild on the banks of the St. John's River just south of Lake George, but it probably does not now grow so far north. In this connection Sir Charles Lyell gives an account of immense orange trees ninety years old on the lower Altamaha River and others

one hundred and fifty years old at St. Augustine! These ancient trees were killed in 1835 by perhaps the severest cold ever recorded in Florida. Since then there have been such repeated cold spells and at such short intervals that many of the more tender plants have never recovered.

At the point where we visited Coot Bay the shore was covered with a dense growth of buttonwood. In this low, swampy thicket Mr. Roberts showed me the ruins of a shack built and occupied by the late J. E. Layne, a young man of much ability, who devoted his life to collecting the plants of the southwestern part of the State. The wretched little hovel could not have been more than ten feet square; it was made of poles and only a couple of feet above the mud and water. Here, alone, in this desolate place, tormented with insects, he did excellent work as a collector and botanist. Why did he abandon civilization and become a hermit; was it trouble or desire for discovery? He died from exposure and the want of proper care,—a martyr to the cause of science.

In a low hammock we found an abundance of the superb epiphytal orchid *Oncidium luridum*, with heavy, broad, folded leaves, often three feet

long. Its branching flower spikes occasionally reach a length of ten feet. The hundreds of rather large flowers in the clusters are greenish yellow barred with brown-red. With it grew another interesting orchid, *Epidendrum anceps*, which we had never found elsewhere.

My face was badly swollen from too many mosquito bites. The insects covered the exposed parts of my body until the skin could not be seen, and when I wiped them off the blood dripped on the ground. With puffed cheeks and eyelids I could scarcely see and, thoroughly poisoned, I felt stupid with desire to lie down anywhere and sleep. One of my companions, Mr. John Soar, began to be ill from the same cause though his face did not swell. His exposed skin turned fiery red and he seemed to be in a serious condition. About that time Mr. Roberts found some wild limes, the juice of which he applied to the afflicted parts, relieving them almost instantly. There are well-authenticated instances in Florida and elsewhere of death occurring from the attacks of mosquitoes. The victim becomes semi-torpid from the poison and lies down to sleep—his last sleep.

On another occasion in company with Mr. Soar

I visited Madeira Bay, one of the small gulfs on the south coast about twenty miles east of Flamingo. On account of shallow water we anchored our launch outside the narrow neck and attempted an entrance with a skiff, but we were soon aground and had to get overboard and push,—as usual. At every step we sank deep in the soft mud but after about a mile of it we found deeper water and pulled to the opposite shore, where we found the Cuban palm (*Acœlorraphe wrightii*) in considerable numbers. We then poled up a creek near the east end of the gulf and entered a large lagoon, and beyond that a second smaller one. Turning back towards evening we started for the launch. Soar thought that by hugging the shore we would find deeper water, but soon it shoaled to an inch. We had been all day without food or water and were so thoroughly exhausted that after pushing the boat but two or three rods we had to rest on the gunwale,—"all in." Finally in the night we reached the launch, threw ourselves upon the bottom, and supperless slept until the sun was well up in the sky.

On still another occasion I went with a party to obtain specimens of the Cuban palm for plant-

ing. At Flamingo we hired one John Douthett to act as guide and to furnish a shallow draft gasolene launch. On account of shoal water we anchored near Jo Kemp's Key, making the balance of the trip in our skiffs. From the key we had a nine mile run in water nowhere more than two feet deep and most of the way we dragged the bottom. Here we saw no end of birds, particularly white and brown pelicans and Florida cormorants. The first of these swim along and scoop up fish while the second fly in circles and swoop down on their prey.

In about two hours we entered the mouth of a creek near the head of an unnamed bay. A half mile up the stream we entered a considerable lagoon which we passed through and then passed into the same or another channel, for in this region there is an interminable maze of brackish lakes and passages. The latter are crooked and difficult to navigate but we pushed on first northeast, then north, northwest, southwest, then abruptly to the northward to Cuthbert Lake, some nine miles from where we first entered the creek.

The whole trip was novel and exciting. No less than six lakes, each concealed from the rest by

dense growth of littoral forest, were crossed before we reached our destination, and several times Douthett got into the wrong channel. I cannot understand how anyone first could have found his way through this labyrinth or, once accomplished, ever follow it again.

Over the channels great mangroves arch, dimming the sun's glare to soft twilight beneath. Air roots everywhere descend into the channels so completely obstructing the passage that we had frequently to chop our way through. Immense orchids (*Cyrtopodium punctatum*) were in bloom among the trees, and a world of air pines and Catopsis cling to the branches. On the ground are gigantic ferns (Acrostichum), forming the densest thickets, and a monster vine (Ecastophyllum) sprawls over everything. Here and there a great courida (Avicennia) towers above the mangroves; the ground beneath being thickly covered with erect quills or pneumatophores, the curious growth from the roots of this tree.

One of the anomalies of this general region is the cacti. We usually associate such plants with desert or semi-arid places but along this southern shore one or more Opuntias and two species of

Great Orchid, *Cyrtopodium punctatum* in bloom at Snake Hammock near Coot Bay, Florida. Plant Had Thirty-one Flower Stems over Four Feet Long, with Perhaps a Thousand Blossoms

Photo by Dr. John K. Small

Cereus grow profusely in damp or even muddy situations where an unusually high tide may cover their roots. In fact it seems that these desert-loving plants are attempting to become aquatics. Along our strange course where the ground becomes too swampy they grow as epiphytes, attaching their roots well up on the trunks of living or dead trees.

Douthett's propeller had only one blade and it revolved at a terrific rate. How it survived the trip we could not understand, for it struck the rocky bottom every revolution for long distances, and we navigated through a tangle of sunken logs, branches, and chopped-off mangrove roots. As we proceeded the channel became narrower and more clogged and often we were obliged to get out and lift the boats over sunken timber, or depress the bows to get them under a log, then all get in the stern and shove. For considerable distances we were compelled to lie in the bottom of the boats to avoid the low branches and air roots which hung about everywhere. At one in the afternoon we entered Cuthbert Lake, a nearly circular body of brackish water a mile across. We found patches of the palm we sought and at once set to work

grubbing up and loading them on the boats. Immense numbers of a large white bird in the lake continually uttered a harsh croaking call,—probably the white ibis (*Gaura alba*).

This locality is one of the last resorts of some of our most beautiful and interesting wading birds. Here in days gone by resorted vast numbers of gorgeous flamingos, scarlet ibises, roseate spoonbills, and roseate terns. This was one of the chief breeding places of the ethereally beautiful egret (*Herodias egretta*) and the even more perfect snowy heron (*Egretta candidissima*). Owing to woman's vanity and man's greed they are now well-nigh exterminated. The men who raid these heronries are toughs and outlaws, and there is not one of them to-day who does not gloat with satisfaction over the foul murder of the faithful game warden, Warren Bradley, who was shot down by their gang while trying to preserve these birds.

This entire region (which is of little value for anything else) should be set apart by the federal government as a great bird reservation, but even then it would be difficult enough to protect the birds within it, for the same men who killed

Getting Out New Palm, *Acoelorraphe wrightii,* at Madeira Bay, Florida

Photo by Dr. John K. Small

Bradley would not hesitate to do the same by any other warden.

Towards evening we finished with our palms and started on our homeward trip, which, by reason of the load, was more difficult than the up journey. It was after sundown when we reached the bay and then engine trouble beset us. We cranked and talked to it in vain and at last giving up we settled down to spend a miserable night in the crowded little launch and its tow. A cold wind arose from the northwest and the sky was overcast with ominous clouds. We were exhausted, wet, and hungry, as we had had no food since morning. No doubt by reason of the fact that I was much the oldest of the party I suffered greatly with the cold. I asked Douthett how far he thought it was to our larger launch and he said it was probably a couple of miles. Then I asked if he had any idea which way it was and after standing up and looking around for some time he pointed and said: "I think it is off there."

I tried to get the men to pole but they doubted if we could find our boat and were disinclined to make the effort. At last to warm my chilled body I commenced poling. Later Douthett joined

me and in an hour we distinguished a blur on the water ahead which proved to be a launch and the boys set up a cheer. When we came to it we found to our disgust it wasn't ours. We aroused the inmates, who were naturally a little peevish at being disturbed in their sleep by so unprepossessing an outfit. So we began the search all over again and at last—joyful sight!—our own boat. Never before was sleep so sweet or better earned.

Why should an old man, past the age when most persons seek adventure, leave a comfortable home and plunge into the wilderness to endure such hardships? What rewards can he receive for it? I never return utterly worn out from such a trip but that I vow it is the last. But in time the hardships are forgotten and recollections of the pleasant features only remain and I am ready to start again. There is in all this a sort of fascination not easy to explain—the relief that comes from being away from all the restraints and artificialities of communal life—and then, the "call of the wild." There is a wonderful inspiration in the great out of doors. Everyone feels it,—some more, some less. Personally I cannot resist the call and

must respond when I hear it and understand its meaning.

There is upon these outings the cherished comradeship of one's fellow-naturalists. One never really knows a man until he has gone out with him on a cruise or a long tramp. If there is any little meanness or petty selfishness in his make-up it will then crop out. If he is a clean man the fact will be proven by hardships of the road. I have been especially fortunate in my companions on many such rough trips and how often have I been surprised by their kindness and self-denial. My memories of these trips, of the dear companionship, of stories told around camp fires and on deck are easily my most cherished possession.

It was in the wilds that Humboldt, Darwin, Wallace, Bates, Spruce, and the splendid company of the earlier and greater naturalists studied and worshiped Nature. They were interested in every phase and detail of it; their contact with it made them broad and big and able to see the great truths. There are many specialists who study intensively some small group of animals or plants until they know more about it than anyone else, but they

have too little general scientific knowledge, and they care too little for the great scheme of nature. In fact they are too little. They may slave on the anatomy or heredity of a few things but they neglect the larger questions of environment and distribution. They are closet students,—scientists, not naturalists; their whole occupation is business, they find neither beauty nor charm in it. They dig in a tunnel and see nature through a pinhole.

One of these scientists, a man well known as a distinguished expert in his specialty, once astonished me by saying: "All this talk about the beauty and harmony of nature is nothing but pure bosh! I do my work and make investigations as a lawyer would on a case; it is simply business. I do it to win my suit, to succeed, to make a reputation."

I do not want to investigate nature as though I were solving a problem in mathematics. I want none of the element of business to enter into any of my relations with it. I am not and cannot be a scientific attorney. In my attempts to unravel its mysteries I have a sense of reverence and devotion, I feel as if I were on enchanted ground. And whenever any of its mysteries are revealed to me

I have a feeling of elation—I was about to say exaltation, just as though the birds or the trees had told me their secrets and I had understood their language—and Nature herself had made me a confidant.

CHAPTER VI

The Everglades

IT is quite probable that the creation of the Everglades was one of the last acts in the completion of the land now forming the State of Florida; in fact the process of construction appears still to be actively going on. It is estimated that the region contains about 5000 square miles, but the latest investigations slightly reduce this figure. It about equals the area of Connecticut though its borders are so vague and uncertain that no survey could precisely determine its limits. Samuel Sanford, who has carefully studied the geology of South Florida, says: "A difference of two feet in water level means the difference between shallow lake and dry land for hundreds of square miles."

The popular idea of the "The Glades" (so the Floridians generally call them) as a great basin is erroneous. At the south shore of Lake Okeecho-

bee, which for a distance is the northern limit of the Everglades, the land is elevated twenty feet above sea level. From the lake it gradually slopes southwesterly to the Gulf of Mexico, also southerly to the Bay of Florida, and finally south-easterly to the Florida Strait. Muck, peat, and sand form most of the normal surface of the great swamp and these rest on a foundation of soft limestone. For ages the rains have been dissolving this rock, forming pools which afterwards became ponds and lakes. A rank growth of herbaceous vegetation has occupied these basins and in decaying has slowly filled them with muck and peat. The region about Okeechobee was elevated long before that farther south, hence the lake or pond basins of that area with a longer time for the process were dissolved out to greater depths, and became more or less filled with vegetable deposits. Lakes Flirt and Hicpochee are nearly silted to the water level and were once, most likely, a part of the great lake.

The southern part of the Glades was recently elevated and there has not been sufficient time as yet to dissolve out any considerable basins, or to form any great depth of vegetable deposits. In fact the rock appears on the surface over extensive

areas in the newer part of the great swamp. In this connection the settlers make a distinction founded on the depth of muck, and speak of the "Upper Glades" and "Lower Glades." In the upper (northern) part of the swamp the saw grass is much more dense than elsewhere and it is said that the Seminoles never attempt to cross that section.

Whenever Okeechobee becomes filled to overflowing the surplus water pours out and over the Glades. The dense growth of saw grass and other herbaceous vegetation prevents it from running rapidly to the sea although there is a gradual fall all the way. For this reason most of the region becomes covered with water which moves slowly seaward. When the water of Okeechobee is confined within the lake the water slowly drains off and the glades may become dry. The decaying vegetation around the border of the lakes has slowly built up the land. The outflowing water has deposited a considerable amount of silt at the rim, still further assisting in the land building. It may seem strange that two such causes should actually raise the level of these large bodies of water, but before drainage operations were begun,

Upper View. Edge of Everglades along Tamiami Trail

Lower View. Everglades near Paradise Key

Photo by Wilson Popenoe

their surfaces were several feet higher than when first formed.

It has been asserted that the large lake and the Everglades are partly supplied with water by subterranean streams coming from the Appalachian region. The fact that powerful springs often gush forth from ditches in the Glades lends color to the assertion, but I do not believe it true. During 1915 and 1916 there was a considerable shortage of rainfall in the Everglade region and this loss, further increased by water taken from the lake by three canals, so lowered the level that perhaps a hundred square miles of its western and southern part were laid bare and no water at all could be found over the general surface of the great swamp. Had there been a subterranean flow the results of a local drought would have been less pronounced.

The flora of the Everglades includes a number of gigantic herbaceous plants, and of first importance among these is the "saw grass" (*Cladium effusum*), which is perhaps the most characteristic growth of the region. It is not really a grass at all but a member of the sedge or bullrush family and only distantly related to the true grasses. It has long,

grasslike, folded leaves which spring in a great tuft from the root and the slender leaves are armed on their edges with sharp teeth like those of a rip saw. And a veritable rip saw it is, as anyone who once comes in contact with it will agree. These leaves attain a length of seven feet, and in late spring or early summer the plant sends up a nearly round flower stem to a height of ten feet or more. This stem is protected with a bodyguard of these savage leaves gathered about it. It has many panicles of brownish flowers and when viewed from a distance a stretch of it is an attractive sight, but it is just as well to see it only from a distance. Willoughby and others who have crossed the Glades give graphic pictures of their bloody battles with this merciless sedge.

One of the most striking and interesting of these large plants is the "gama grass" (*Tripsacum dactyloides*) which is sometimes cultivated for ornament. It has broad, fine leaves and reaches a height of twelve feet or more—the long flowering stems have the seeds hidden in excavations along their sides. There is a giant foxtail (*Setaria magna*), a brother of the cultivated millet, which seems to be rapidly spreading through the drier

parts of the Everglades. The common name of this plant is from the striking resemblance of its long, hairy flower heads to the tail of a fox. This species attains a height of quite fifteen feet and its immense heads are often two inches in diameter and as many feet long. I have elsewhere mentioned the Phragmites or common reed, hollow stems of which are used for plant stakes and a variety of other purposes. It is abundant in places. Often associated with it is a boneset which grows ten feet high and also the elegant Thalia with its attractive purple flowers held aloft. In suitable stations there is an exaggerated bullrush (*Scirpus validus*) fully fifteen feet high, with stems a generous inch in diameter.

An immense weed belonging to the Amaranth family seems to be spreading over the recently drained parts of the swamp. It is the water hemp (*Acnida australis*) and it frequently attains a stem diameter of more than a foot and a height of twenty feet; yet this gigantic plant is an annual and makes its astonishing growth in a single summer. In places it densely covers large tracts, and at a little distance may easily be mistaken for real forest. Its great trunk, however, is little

more than water and some fiber. At Okeechobee I saw a man throw a sharpened lath at the stem of one of the largest of these plants and drive it clear through so that the point projected on the other side. One can hardly understand why so flimsy a stem is not broken and overthrown by the wind, especially since it chooses the most exposed station.

Wonderful as is the growth of the water hemp it is completely outdone by that of another native plant, *Agave neglecta*, which lives in the pinelands along the border of the Everglades. It requires five or six years for this agave to complete its huge rosette of basal leaves,—the whole often being over fourteen feet across. Then up shoots a pole or flowering stem which, just after the start, grows at the rate of two feet a day. I measured one of these stems,—thirteen inches in diameter at the base and *forty-two feet eight inches high!* This astounding stem was produced in about a month!

Generally there are few attractive plants in swamps, but in the Glades there are many. *Canna flaccida* (a cousin of the cultivated species) has exceedingly pretty yellow blossoms. The pickerel weed (Pontederia) with heads of blue flowers

Paradise Key with Native Royal Palms. An Island in the Lower Everglades

Photo by Wilson Popenoe

is everywhere abundant and the handsome water hyacinth, such a nuisance in the fresh waters farther north, is gaining entrance by the canals. *Crinum americanum*, a bulbous plant, has lovely, pure white, fragrant blooms and two species of Hymenocallis or spider lilies display their offerings in large blossoms, the long white segments of which suggest the ribs of an umbrella,—the whole being surmounted by a lovely crown. There is a handsome blue Nama and two charming pond lilies, one a Nymphæa with yellow and the other a Castalia with white flowers. The latter is one of the common pond lilies of the north. The leaves of the yellow lily are strong and erect and the plant usually bears the name of "bonnets."

Great masses of a cattail (*Typha angustifolia*) are often met and occasionally the arrowheads (Sagittaria), with lance-shaped leaves. In the canals the curious water lettuce (*Pistia stratioides*) floats down from the lakes, where there is a great variety of interesting aquatic vegetation. The boneset, Thalia, Nama, maiden cane, and some others are from the north while the saw grass, Crinum, gama grass, spider lilies, the foxtail, water hemp, giant bullrush and water lettuce are

purely tropical and are derived from Middle America. The pickerel weed and common reed are widely distributed. The cattail extends north to Canada and south throughout the West Indies; it also lives in both Europe and Asia and now in New Zealand. It is probable that a majority of the plants of the Upper Glades are of northern derivation and that the greater part of the flora of the southern end is Antillean.

Although only the preliminary work of drainage has been done yet it has had a marked effect on the vegetation. Along the banks of the canals and on all slightly elevated spots a variety of trees and shrubs are springing up, so that where formerly the eye swept over a monotonous even expanse of saw grass, the view now presents patches of incipient forests. This new element in the flora is especially noticeable around the eastern border which is somewhat drier than the main body of the swamp. Here groves of young timber are claiming titles on every hand.

One of the results of partial drainage is that along this same east border numerous low, timbered "islands," which were formerly quite wet, have now been changed to dry land. A con-

siderable part of the foundation of these groves is peat and in dry times it is very liable to fire, and once begun it is well-nigh impossible to extinguish it. These groves, despoiled of their only defense against fire, are often wholly destroyed. So it happens that while the draining of the Everglades makes it possible for forests to spring up and flourish in some places it is the cause of their destruction in others.

The animal life of the Glades is most interesting and especially so as regards the avifauna, or rather, as regarded it. This was the home of the flamingo, the terns and gulls, the scarlet ibis, and the roseate spoonbill. Here too were myriad egrets in dainty, snowy robes, the capricious brides of the feathery kingdom. All gave life and color to the great swamp. Still lingering here are the strange limpkins—*Aramus vociferus*—that wail out their "whee-ee-eu"; also the equally strange snake bird *Anhinga anhinga* which swims with the body submerged and only the serpentlike head and neck visible. There are herons, bitterns, coots, ducks, the cormorant, the Everglade kite, and many others, but the heydey of bird life has passed and is passing. The wildcat makes its

home on the "islands" and along the borders of the Glades preying upon its smaller mammals; deer are still found occasionally; raccoons and otters are fairly abundant.

The waters are well stocked with fish of several species. Black bass is common, but the most notable of fish is a gar pike belonging to the genus Lepisosteus which differs in many essential points from all other groups of the present day. There are supposedly three species of this genus in the waters of the United States, one of which also extends its range into Cuba. A fourth species is Central American and a fifth Chinese. These ganoids (as the order of the gar pikes is called) date their origin in the Lower Silurian period—many many million years ago. Together with the sharks which also inhabited these primordial seas and still exist in our waters, these were the first known fishes of our planet. The ganoids swarmed in the ancient oceans of pregeological epochs, but few species remain to-day. The Everglade pike is one.

The entire ganoid structure is "old-fashioned" to a remarkable degree. In the earlier forms the skeleton was cartilaginous but in the recent

species it is more or less ossified. The vertebræ have ball and socket joints, like those of the serpents, and wholly unlike those of all other fishes (inverted cone). The head moves on the neck independently of the body. The scales of the gar pikes are so hard that fire may be struck from them with a piece of steel, and they are arranged in diagonal rows running from the back downward and backward. They are very curiously fitted together, in some cases being fastened to each other by a system of hooks; they do not lap over as in regular fishes but form instead a coat of armor. A remarkable fish indeed!

I never look at one of these strange creatures so abundant in the Glades, but I am reminded of the serpents and feel more and more sure that they developed from these ancient fishes. The sight of some survivor from the early dawn of life always fills me with awe and reverence. A few Brachyopods or lamp shells still inhabit our seas though they developed and lived in myriads in the old Cambrian ocean, among the very earliest forms of life known to inhabit our world. Two of their genera, Lingula and Discina, which are among the oldest genera known survive to-day and living

species of these groups can scarcely be separated from the ancient fossil ones. A remnant of Crinoids or "stone lilies" still survives and this order too goes back to the first days of life.

What a wonderful amount of generic vitality such creatures must have; what powers of adaptation to diversified environment; what ability to hold on tenaciously to their structure and family characters throughout the countless ages! We boast of our old families that date back some generations but here are creatures whose ancestors have kept their vigor and likeness a thousand times longer than the human race! I feel like taking off my hat and bowing to them.

Shortly after coming to Dade County I made a trip to Paradise Key, a large island in the Lower Everglades and covered with magnificent hammock. I went in company with my neighbor, John Soar, and A. A. Eaton, a man in the prime of life and an excellent botanist. He had a fine physique, was full of life and humor, was most companionable and altogether one of the best woodsmen I ever knew. We were always pleasantly bantering each other. We drove over pre-

posterous roads to Camp Jackson, a sort of depot of surveyors for the Florida East Coast Railway, and lying on the edge of the Glades. Thence with camp outfit we proceeded afoot for the island, three or four miles away.

The surface was irregular rock, which, as we proceeded, became covered with water and so slippery that we were constantly sliding into pot holes. In fact the walking consisted mostly in slipping down and getting up again. At length we reached the headwaters of Taylor River and Soar suggested that we keep close together when crossing. Eaton asked why and was told that there might be alligators or crocodiles. He contemptuously offered to eat the entire saurian supply that might be found in Dade County, and boldly waded in. In midstream, the water to his armpits, there suddenly began a tremendous commotion and for a minute the surface of the stream was all arms, legs, blankets, and camp equipage, along with the tail and body of a monster alligator. Eaton finally crawled out looking very pale and explained that he had stepped on what he thought was a log. When we finally waded across Soar took the lead and Eaton stuck very close to me.

After that I frequently reminded him of his promise to eat the alligator crop.

We tramped through the magnificent forest of Paradise Key, leaving our equipage beside a very tall royal palm where we entered. Soar skinned a rattlesnake which Eaton shot and I collected a large bag of rare orchids; then we started back to our outfit but, after searching an hour, we were unable to locate it. At last Eaton climbed a tree and saw it just to the right, we having passed close to it a number of times. We had intended to camp on the key but for some reason Soar and Eaton thought it better to return to Camp Jackson, so we started about sundown. On the way Soar became dreadfully ill, probably from the offensive odor of the snake, so Eaton hurried on to a clump of scrub ahead, hung up his load, and returning took that of Soar. He said he would push on to an incipient hammock we had passed coming in and we would make camp there.

As he disappeared in the darkness I took his bearings by a star and slowly followed. The sack containing my orchids weighed about forty pounds at starting, but gradually increased to the size and weight of a freight car. I constantly fell into pot

holes, and once I lost my pack in the saw grass. At last I made out the little scrubby growth, and on entering I stumbled over Eaton's pack, but though I called I got no reply.

From a dead limb I shaved off some kindling and soon had a fire started. Poor Soar, now very weak, saw the light from a long way off and headed slowly for it, and soon Eaton arrived with a lightwood log that he had obtained from the forest beyond. He said that the building of that fire was the only sensible thing he ever knew me to do. Soar finally arrived in dreadful condition and he vomited most of the night. We were camped on a small ragged rock which nowhere rose more than a foot above the water and was full of pot holes. Here we turned in for the night on the most wretched bed I ever saw. Towards morning we all slept but at dawn I got up to stretch my cold, aching limbs. Within twenty feet of us was a fine dry island a rod across, almost perfectly level, covered with nice soft grass,—an ideal place for a camp. Eaton suggested that we each take turns kicking the others and he basely attempted to lay the responsibility of the camp selection on me.

On our way back to Miami we camped near the shack of a couple of tall, solemn-looking Georgians who lived on the edge of the Glades. They came out to inspect us when they were through supper. Eaton was in excellent spirits and constantly rallied me, and I retorted as best I could. When bedtime came I went with the Georgians to get a pail of water from their well when one of them said to me: "That feller's mighty aggrivatin'." I agreed that he was and the man said "Do ye know what 'ud happen in my country if one feller abused another the way he done you-all? Thar'ud a bin some shootin' a-goin' on, mighty quick; you kin bet yer life on that." Poor Eaton! He went north, married the woman of his choice, and wrote me how supremely happy he was,—and then I heard of his sudden death. Had he lived he would have become famous as a botanist.

Shortly after the opening of the North New River Canal I made a trip from Ft. Myers up the Caloosahatchee River, through the Disston Canal and Lake Okeechobee to the little settlement of Rita, thence down to Ft. Lauderdale. I had made many visits into the edge of the great prairie before but this trip gave me my first true idea of its vastness and

sublimity. A heavy belt of pond-apple forest (*Annona*) skirts the south shore of Okeechobee but soon it faded from view as we moved down the canal. Then for hours we passed a reach of saw grass, apparently as level as the lake itself and extending in solemn grandeur without interruption to the horizon,—only grass and sky.

This is in the "Upper Glades," its limestone foundation deeply buried under a bed of muck. Although the surface appeared to be absolutely level the strong current in the canal told another story. Some thirty miles from the lake the rock appears on the surface, and as usual is full of pot holes which, in turn, are filled with muck; then comes a belt of soil, said to be deep; farther on the rock again reappears.

I remained on the upper deck of the boat during most of the passage, fascinated by the wonderful scene. It differs from the prairies of the Upper Mississippi Valley in being flat and partly covered with water, whereas they are rolling and dry. There is a suggestion of the sea in this vast stretch of swamp. Smoke arose far away to the southwest, no doubt from a fire in the Lower Glades, as though from some steamer hull down below the horizon.

Since the opening of the canal I again crossed the Glades but on account of low water the boat from Fort Myers only carried me to La Belle on the Caloosahatchee. I induced a man going up stream in a skiff launch to take me to Rita on the lake. Just as we were starting he was hailed by three men in a rowboat who immediately came aboard, fastening their craft behind ours. They were all fishermen who plied their trade in the big lake, and in all my wanderings I have never seen a rougher crowd in dress, appearance, or manners. The man who carried me said he was forty-five but he looked twenty years older with a face dreadfully marked by a rough life and dissipation. He was addressed as "Th' ole man" by the others who were much younger. I was decently dressed, had some money and a watch, and I confess to a little fear of my companions who might so easily knock me on the head and throw me overboard.

We ran up the palmetto-bordered Caloosahatchee, which I consider more beautiful than the famed St. Johns, but towards night our engine began to give trouble and seriously to delay us. It was midnight when we stopped at a shanty along the canal; the men made a fire and cooked

some supper and we made a try for the forty winks. At daylight we resumed our journey with a still balky engine and only reached Lake Hicpochee after nightfall. We had no food all that day but at night I had to force the men to share a few cakes I had with me.

The boatman attempted to cross the lake to a camp where the canal entered and where we all hoped to get food. Before long I saw by the stars that we were wandering aimlessly about and finally the men had to admit being lost. They then hauled the tow alongside, laid a piece of board, some poles, and the oars lengthwise over the thwarts, spread out some blankets and told me that was my bed. I remonstrated against their self-denial but the old man impatiently said: "Oh, d—n it, don't set thar chawin' about it; we got a-plenty o' beddin'," so I crawled in, or rather, on, for a fair night's sleep. In the gray dawn I awoke and looked at my companions in the launch. There was a heavy fog and the air was raw; not one of them had a shred of cover. One was perched in the bow of the boat, one sat on a box, while the other two were just managing to lie on the thwarts, for there was water in the bot-

tom of the skiff; all were fast asleep. These toughs and outlaws had given their blankets to make a bed for me—a stranger—in full expectation of themselves spending a wretched night. Heartily ashamed of myself for having suspected them I conceived a feeling of genuine fellowship for the whole lot! After many more vicissitudes I arrived at Rita and eventually home.

No sketch of the Everglades would be complete without some account of that strange, pathetic remnant of Indian life—the Seminoles. According to a recent estimate there are only about four hundred of them left, and though once a courageous and fierce tribe they are now reduced to the conventional level of very well-behaved and harmless people. They live, a few families together, in widely scattered camps, located on the pine land amid the cypress strands or on islands in the Glades. Their camps are built without any order or accepted plan of arrangement. The dwellings are the merest shelters; they cannot even be called huts. A platform seven or eight feet square is elevated a couple of feet on crotches or posts and the small logs of this are either flattened off into puncheons or left natural. A low span

Permanent Seminole Camp. Pinelands in Tommy Cypress, Back of Head of Chokoloskee River

Photo by Dr. John K. Small

roof, usually of palmetto thatch, shelters the platform and it is open to wind and weather on all sides. In such a mansion the family resides. Their houses must be rather uncomfortable during severe northers although the tenants may improvise some kind of curtains in periods of storm.

The Seminoles raise some garden vegetables—especially a very fine small sweet pumpkin. The men hunt deer and other animals and trap otters for their skins. The women make baskets, bead work, and various trinkets to sell. The latter wear long gowns and a cape bordered with a highly colored fringe; a short jacket beneath does not always reach to the skirt. Many strings of blue or red glass beads are strung about the neck and shoulders, the whole sometimes weighing twenty pounds. Around the bottom of the skirt are one or more belts of striking colors which look as though the woman had appropriated a section of the rainbow. The men wear a shirt that reaches to the knees and is belted around the waist. This shirt is usually decorated with what remains of the rainbow. In some cases they wear a highly colored turban and also trousers but the majority go bare as to head, legs, and feet.

They are quiet and dignified in manner, are absolutely truthful and fully aware of their superiority in this respect over the white man. One of the paleface vices they cherish to an extraordinary degree,—the love of firewater or "why-ome" as they call it. They generally indulge a bit freely when in town, but they are not given to noise or viciousness when intoxicated. A tipsy Seminole can get just a little more wabbly on his legs without actually falling than can any other human being.

Their words are composed of a great number of syllables. Willoughby has given a vocabulary of them in his book *Across the Everglades* and in this only two words have a single syllable while many run up into eight or more. For instance *heron* is "wak-ko-lot-ko-o-hi-lot-tee"; *instep* is "e-lit-ta-pix-tee-e-fa-cho-to-kee-not-ee," and *wrist* "in-tee-ti-pix-tee-e-toke-kee-kee-tay-gaw." I should think it would take a half hour for a Seminole to ask the time of day, but fortunately he has plenty of time.

There is something very distressing in the gradual passing of the wilds, the destruction of the forests, the draining of the swamps and lowlands,

Part of Family of Dr. Tommy Jimmy, at Seminole Camp in Cypress Hammock, West of Kendall, Dade Co.

Photo by Dr. John K. Small

the transforming of the prairies with their wonderful wealth of bloom and beauty, and in its place the coming of civilized man with all his unsightly constructions,—his struggles for power, his vulgarity and pretensions. Soon this vast, lonely, beautiful waste will be reclaimed and tamed; soon it will be furrowed by canals and highways and spanned by steel rails. A busy, toiling people will occupy the places that sheltered a wealth of wild life. Gaily dressed picnicers or church-goers will replace the flaming and scarlet ibis, the ethereal egret and the white flowers of the crinums and arrowheads, the rainbow bedecked garments of the Seminoles. In place of the cries of wild birds there will be heard the whistle of the locomotive and the honk of the automobile.

We constantly boast of our marvelous national growth. We shall proudly point some day to the Everglade country and say: "Only a few years ago this was a worthless swamp; to-day it is an empire." But I sometimes wonder quite seriously if the world is any better off because we have destroyed the wilds and filled the land with countless human beings. Is the percentage of happiness greater in a state of five million inhabitants than

in one of half a million, or in a huge city with all its slums and poverty than in a village? In short I question the success of our civilization from the point of view of general happiness gained for all or for the real joy of life for any.

CHAPTER VII

The Planting of Our Flora

LOWER Florida, including the Everglades, has a mixed flora, consisting, for the most part, of the warm temperate and the tropical forms; the latter somewhat predominate. There are also quite a number of species which are immigrants from north of latitude 40°. Then, too, as almost everywhere, there is an element, always increasing, of species naturalized from the Old World. These are the floral tramps which follow the migration of man and make themselves at home wherever the climate is suitable. A few forms were developed right here from species which originally migrated from the American tropics, and these may properly be called semi-tropical.

During the glacial period of early pleistocene time a great ice cap covered the northern part of America even to the Ohio and Lower Missouri

rivers. The slowly advancing wall of ice and the cold temperature drove the flora southward. We have in Lower Florida at least seventy-five species of plants which also range north to or beyond the fortieth parallel, some of which reach even into Canada. These probably had fled before the oncoming glaciers in the north but finding here conditions favorable for their growth, they remained and became a permanent part of our flora. Some of these have continued their range into the West Indies and a very few, such as the common reed and cattail, have a still wider distribution, even including the Old World. It is therefore impossible to be sure in every case whether a species originated in the north, the American tropics, or in the Orient.

It is probable that before the glacial period, a warm temperate or semi-tropical flora inhabited the region of our present Southern States and a more strictly tropical one the lower part of Florida. The cold of the ice age exterminated the tenderer plants, for although there was no actual ice cap in the Southern States, the many years of continuous winter materially lowered the temperature throughout the south. Some Florida remnants

are recognizable of this old warm temperate and subtropical flora. The porcupine palm (*Rhapidophyllum hystrix*), the blue stem (*Sabal adansoni*) (both of the upper part of the State), the saw palmetto (*Serenoa serrulata*), the cabbage palmetto (*Sabal palmetto*), and two species of comptie (*Zamia pumila* and *Z. floridana*), together with a few other plants appear to be survivors of preglacial days.

A number of large mammals such as the elephant, rhinoceros, mastodon, the saber-toothed tiger, a glyptodon (one of those strange forms which seems to have been intended for a gigantic tortoise but which through some misdeal in creation became a mammal), and many others, then inhabited Florida. They endured here the cold of glacial times and survived to enjoy the genial period which succeeded,—then, for some unaccountable reason, they became extinct. Possibly their vitality was lowered by the long, severe winter.

There are in the neighborhood of 1200 species of native and naturalized flowering plants growing on the lower mainland of Florida and about 50 ferns and their allies. To these add 250 species on the Florida Keys not known to inhabit the

mainland, and we get some 1500 total in an area of 3000 square miles. I confess at first to surprise at the small number of species in a region of the size and lying, too, at the very door of the tropics. On reflection, however, the reason is easily understood. The area considered is very new; it was elevated above the sea only yesterday (geologically speaking) and is scarcely dried off yet. Hence there has been insufficient time to accumulate an extensive flora. The sandy soil is poor, and over much of the area the rocky ground has no covering whatever. Lime is poison to many species of plants and such will not grow in most of our territory. There is but slight variation in the contour of the entire region and this would preclude the mountain species and those affecting elevated or broken land.

I have already stated that the Florida Keys are being worn away and that they formerly occupied a larger area than at present. Dr. Small, who has made a careful study of the flora of Lower Florida, believes that some species of plants which formerly existed on the keys are found there no longer, having inhabited land now destroyed; this view is doubtless correct.

The Everglades stretch almost across the northern part of Lower Florida like a line of fortifications forbidding entrance to dry-land plants of the warm temperate region. According to the map of the Everglades Drainage District the great swamp comes out to the Gulf of Mexico in the neighborhood of Chatham River and extends south along the Ten Thousand Islands to Cape Sable, but there is at least one considerable body of hammock land along Rodgers River. At any rate the immigration of the more northern dry-land plants is prevented on the west and they can only enter the lower part of the State along the sandy, rocky ridge near the east coast. The seeds of a few like the thistles and other Compositæ may have been wind-borne from the northward.

All the tropical part of our flora has migrated in some way across the sea; even the seeds of Cuban plants must have crossed a strait at least ninety miles wide. The question of how they reached our shores and became established is a very interesting one.

It has been claimed that a land passage connected Cuba and the lower end of Florida within the lifetime of our existing plants and animals, but

in another chapter I give my reasons for believing this an error. Many tropical trees and shrubs produce berries and drupes, the seeds of which are indigestible but the surrounding pulp is relished and eagerly devoured by birds. The seeds may be carried long distances before being ejected, and as they retain their vitality they may germinate and grow in distant regions. Guppy has written his observations in the Pacific, and the burden of it seems to be to prove that birds do almost all the carrying of seeds across oceans. He believes they have transported many plant species from the American tropics to the Hawaiian Islands, a distance of three thousand miles. It seems to me more probable that most of the American plants now found in the Pacific were transported as floating seeds or on timber at the time when an Atlantic current passed westward through what is now the Isthmus of Panama.

There are hundreds of trees and shrubs in Cuba which bear edible drupes and berries, but very few of them have become established on our shores. For example, there are more than seventy species of Eugenias and their allies in that near-by island which have fruits adapted to bird transport, yet

we have only ten of them in Florida and two of those are possibly endemic. I cannot believe that any substantial part of our tropical flora has been planted in this way. Most of the drupes and berries in Cuba ripen in the summer and autumn. Our migrating birds go to that island in the fall and remain through the winter (or pass farther south), returning to Florida in the *spring* when very few such fruits are on the trees.

We have here many tropical herbaceous plants the seeds of which are freely eaten by birds but which are as freely digested. Such seeds, then, could not under ordinary circumstances have been bird-transported to our territory. It is possible in very rare cases that birds having eaten such seeds in Cuba might at once fly across to Florida and be killed immediately on arriving. But even so it is questionable whether such seeds would germinate after having been acted upon by gastric juices.

But there exists another fatal objection against the birds having planted any great portion of our tropical flora. I have shown in another chapter that there are three distinct areas of dry-land life in Lower Florida and that they exist because they

have never been connected since the present life migrated to their shores. I am convinced that this life was largely current-borne and was brought to the different land areas at different times. *If the greater part of our tropical plants had been introduced by birds the seeds would have been scattered promiscuously over our entire territory, and the more tropical part of the State would be inhabited by only a single flora!*

Some of the minute or winged seeds might be, and probably were, carried across during hurricanes, especially those of the air pines, the orchids, Jamaica dogwood, mahogany, and the spores of ferns, but I believe that a majority of our tropical plants were introduced by the Gulf Stream. A number of the drupes, berries, and other seeds float and retain their vitality in salt water for a considerable time. In little bays along the coast of Utilla Island, Honduras, I have seen acres of seeds of every conceivable description densely crowded together and floating,—held, as one might say, in these great warehouses awaiting shipment to Mexico, Jamaica, Cuba, or to Lower Florida. Some wayward current or strong wind might drive them out into the open sea and into the Gulf

Hammock Scene at "The Sentinels," Home of the Author. Tree Loaded with Vines, Long Moss, and Various Epiphytes

Photo by Wilson Popenoe

Stream, thus putting them aboard the great transport which carried them to their final destinations.

On the floor of any tropical forest there are always decaying limbs and tree trunks, and often in considerable numbers. The exposed surfaces of such fallen timber usually decay first and on them soon forms a thin bed of loose soil. Seeds fall on this and find it an excellent place to germinate. On one of these decaying logs in my little hammock I once counted no less than ninety seedlings of trees and shrubs which grew near by,—seven species in all. These little plants came from several different crops of fruit, some of them being three or four years old. Digging into the decaying wood I found many other fresh and sprouting seeds. Here was a garden richly planted and all needed to establish it elsewhere would be transportation of the log itself.

Suppose that such a tree lay in a stream valley, say in North Cuba, and that in time of some great downpour of rain (during a hurricane for example) it was washed into the Florida Strait. The current of the Gulf Stream moves eastward and north at the rate of about three miles an hour and this would rapidly bear driftwood toward Florida,

especially if it was aided by a strong wind. There is a westward and southerly return current or "back wash" along the mainland and the Florida Keys and throughout the entire region prevailing winds are southeast; hence all the conditions favor the landing of such seed-bearing timber on our lower coasts.

Along many tropical shores the waves industriously undermine the forests carrying seed-bearing trees to sea and if these are drifted into this great ocean current they may be brought to our shores. Beebe tells in a recent number of the *Atlantic Monthly* of the great quantities of timber and grass which the rivers of Guiana annually bring down, and all such debris may bear seeds of trees, shrubs, and herbaceous plants. Even considerable islands of matted roots and living vegetation float down these tropical rivers and drift far out to sea.

Some of these water-borne seeds retain their vitality perfectly after a long voyage. Those of at least three species of mucuna or ox-eye sea beans; *Entada scandens*, the great brown sea bean; the magnificent calaba tree (*Calophyllum calaba*); two nicker beans (Guilandina); Canavalias and

Sword or Boston Fern, ***Nephrolepis exaltata,*** **Paradise Key, Florida**

Photo by Dr. John K. Small

others often germinate after being cast up on our beaches; even the fleshy bulbs of Crinum and Hymenocallis are not the least injured by an ocean voyage. Why, then, it may reasonably be asked, do they not spring up and form colonies along our shores? The reason is that local conditions are not congenial for most of them. The material forming the shores of the open sea is impregnated with salt; at times the sea may roll over it, and even if this were not the case a beach situation is too much exposed for most inland plants.

However, the seeds of certain of these species do come up and flourish when thus cast on the outer shores. Leaving out all the naturally littoral forms, such as mangroves and other strand species, we do find in many such places the two Pithecolobiums (*P. guadelupensis* and *P. unguis-cati*); *Reynosia latifolia* or darling plum; two species of Chrysobalanus or coco plum; *Eugenia buxifolia* or Spanish stopper (all small trees), and also several shrubs and herbaceous plants which seem to do nearly as well along the shore as at a distance from it.

During the time of hurricanes tidal waves

sometimes sweep across the keys and to some extent portions of the mainland of Lower Florida, and it is at such times that most of the tropical seeds are distributed over the land. Some years ago, while one of these storms raged, the sea was driven over the southeast coast of the State until it covered all or the greater part of Elliott's and Largo keys. This wave passed inland until a considerable area of the Homestead country was under water. Two men in boats were driven far in the mainland; one immediately pushed out on the retreating tide, the other delayed until after the water subsided, his launch grounded, and he never could float it again.

In his *West Indian Hurricanes* Garriott gives an account of a storm accompanied by a tidal wave that is in point. He says (page 49): "In the month of September of the year 1759 a heavy gale of wind from the northeast so greatly impeded the current of the Gulf Stream that the water forced, at the same time, in the Gulf of Mexico by the trade winds, rose to such a height that not only the Tortugas and other islands disappeared, but the highest trees were covered on the Peninsula of Larga, and at this time (so says Wm. Gerard de

Brahm, Esq.) the *Litbury*, John Lorrain, master, being caught in the gale, came to anchor, as the master supposed, in Hawke Channel, but to his great surprise found his vessel the next day high and dry on Elliott's Island and his anchor suspended in the boughs of a tree." This sounds a good deal like a "fish story" but I give it for what it may be worth. It will be noticed that Key Largo is called a "peninsula," and at the time of this storm it no doubt was. Such tidal waves as this could easily carry floating material far out upon the land and the storms which cause them almost always occur in the late summer or fall, the very time when the greater part of the Cuban and Bahaman seeds ripen.

It is probable that there may be at intervals, a series of years when conditions are especially favorable for the transportation of tropical seeds to our shores and for the planting and establishing of them in suitable stations. During such time there would be little frost or drought and hurricanes would visit Cuba or the Bahamas and sweep over to our shores. Then on the other hand come years when we may be visited by a severe frost or drought; the forest fires may sweep over wide

areas and exterminate well-established species. In time of very cold weather the mangroves and other littoral trees are sometimes entirely destroyed along extensive reaches of our coasts. I have seen nearly every young plant of the paradise tree in a dense hammock killed by freezing. The same is equally true of certain other kinds of very tender trees. There are records of plants collected by the older botanists in Lower Florida not found here now, and it is all but certain they were not exterminated by man.

In the northern part of Lower Florida the tropical vegetation is almost entirely confined to the seashore and its immediate vicinity. This is caused by the fact that the temperature along the ocean is several degrees warmer than it is a short distance inland. Birds carry tropical seeds from the shore and drop them in the interior but owing to the winter cold they either do not grow or the plants die when very young. In the southern parts of Monroe and Dade counties the inland climate is warmer and at Paradise Key in the Everglades (thirteen miles in from the nearest shore) over fifty species of tropical trees are found. A nearly equal number grow in a hammock close

to the sea at Fort Lauderdale, fully fifty miles north of Paradise Key, but almost no tropical flora is found a couple of miles back from the shore. At Chokoloskee, on the west coast, a large number of tropical forms are met, but five miles away from the gulf the vegetation is warm temperate. A few of the hardier West Indian plants extend their range for a distance up the coasts and some even into the interior of the peninsula.

Along the west bluff of Indian River, just south of Fort Pierce, in latitude 27°30′, I found thirty species of tropical trees and shrubs. Ten rods inland there began to be a few species of warm temperate trees and at twenty rods back scarcely any tropical species were to be found. Just to the west of this fringe of hammock is a series of nearly parallel, lofty sand dunes which deflect upward the cold north-west winds, carrying them over the top of the forest and at the same time inviting an eddy of warm air from the river to draw in and protect the vegetation of the beach. No doubt the cold air settles immediately in the lee of the ridge, thus preventing the tropical growth from extending to it.

Quite a number of species of our native tropical

trees, near the northern part of their range, do not bear fruit with any regularity. In fact they may be entirely barren for a series of years, or at most produce but sparingly. *Simarouba glauca,* one of the quassia trees, grows to a large size in the northern part of our area, but I have never seen it bloom or seed. That it does sometimes do so, even as far north as Fort Lauderdale, is certain, for in the hammocks young trees are abundant. *Pisonia obtusata* seldom fruits, while *Pithecolobium guadelupense* and the fiddlewood (Citharexylum) often fail for one or more seasons. After a shorter or longer period of barrenness there may come such an abundant crop of seeds that the ground under the trees is fairly covered with them. The reason for this variability of production is easily explained. The winter climate of the northern part of our area is so cool that some of these tenderer trees seldom develop flowers or fruit. A hard frost may occur during the blooming or setting period but the tree itself may not be greatly injured; hence its barrenness except when the season is favorable. Insects or drought sometimes destroy a crop. Again it is possible that some years these trees overbear and thus so exhaust the soil it

Nephrolepis biserrata, Sword Fern on Palmetto. Fronds Eight Feet Long. Cutler Hammock

Photo by Wilson Popenoe

requires some time to recover. This irregularity may be due in part to the poverty of the soil, for even our cultivated fruit trees with all the diligent care we give them usually produce more abundantly on alternate years.

If all the seeds from a "bumper crop" germinated there would not be room for the little plants to stand and nearly all would die of overcrowding. So the trees seem to resort to an expedient, as do many animals. They apparently use devices which if employed by humans would be attributed to reason. They cannot voluntarily regulate their bearing but they seem able to control their seeds for a time after they have fallen; in other words, they adopt a sort of balance wheel principle in the germination of the fruits to counterbalance the irregularity with which they produce them. So it often comes about that only a few seeds may come up at once and those of a single crop may continue to germinate for a long series of years. This gives them a far better chance, for if all grew at once (granting plenty of room), a hard freeze, a fire, a drought, floods, insects, or disease might destroy them all. They do not put all their eggs in one basket.

Twelve years ago I introduced *Leucena glauca,* a handsome naturalized tree, into my grounds, but finding that it spread by means of its seeds until it became an unmitigated nuisance I dug it out entirely. Ever since its seeds have been coming up by thousands and there is a prospect that they will continue to do so for many years to come. Elsewhere I have mentioned the fact that seeds sometimes fall before they are mature and that they no doubt ripen afterwards while lying in the ground. This is probably the case with Leucena; a few only are ripe when they fall and they at once come up, while the rest slowly mature and grow through a long series of years.

I have noticed a curious thing in connection with the germination of the seeds of our wild papaw. When I first occupied my home it did not grow in my hammock but in a year or two an immense number of seedlings sprang up which in two or three years became small trees and bore abundant fruit. As it is short lived the plants quickly matured and began to die, so in a few years not one could be found. The seeds which produced this crop of trees were undoubtedly in the ground when I came, and had sprung from a

Beautiful Native Shrub, *Tetrazygia bicolor.* Near Peter's Prairie in Pineland, Lower Dade Co.

Photo by Dr. John K. Small

former set of plants. Either the conditions had been unfavorable for their germination or the seeds may have been immature. It is probable that in the near future there will be another crop. The same thing is true of *Trema floridana*, another of our small, short-lived trees, and perhaps of some others. Our common swamp magnolia (supposed to be *Magnolia glauca*) grows to be a large tree and produces seed abundantly, but while the parent lives one rarely sees a young plant under or about it. As soon as it dies a host of seedlings come up, closely filling the space where it stood, and for a series of years a battle royal takes place between the young trees. The stronger gradually choke out the weaker ones and eventually two or three overcome all the rest, or it may be that only a single victor will survive, to occupy the site of the former tree.

There are a number of plants found in the Homestead country in Dade County not known from any other part of the United States. Among these is the beautiful *Tetrazygia bicolor*, a shrub of the fire-swept pine woods but becoming a small tree in the protected hammocks. It belongs to the Melastomaceæ, a family which has its metropo-

lis in the American tropics but is feebly represented with us. When covered with its great heads of white blossoms it is one of our finest ornamentals. Besides this there is the myrtle-of-the-river (*Calyptranthes zuzygium*), *Alvaradoa amorphoides*, a few other trees, and a variety of herbaceous plants, including a number of ferns. A lovely Cuban vine (*Ipomœa fuchsioides*) with large crimson flowers scrambles over the rocks and sometimes the low trees and shrubs. The seeds of all these may have drifted in and gained a foothold on the rocky ridge at a time when the great brackish swamp lying to the southeast of Homestead was wholly under water and before the final elevation of the Upper Keys.

It is possible that our streams, short and narrow as they are, sometimes act as barriers to north or south migration of certain of our plants. *Ceratiola ericoides* and *Bejaria racemosa*, two large shrubs common in the northern part of the State, extend to Little River but do not occur south of it; nor does the laurel oak which has a somewhat similar distribution. An appreciable number of tropical plants do not pass north of the Miami River, such as *Lysiloma bahamensis*, *Drypetes*

keyensis, *Exostema caribæum*, the Jamaica dogwood, and several others. As these streams all rise in the Everglades and empty into the sea the plants cannot migrate around them. The water alone does not prevent their passing, but the low hammock and swamp on each side of it may do so.

To this it may be objected that as the birds eat the drupes and berries of many of our hammock trees and shrubs, ejecting the seeds undigested, the watercourses could form no barrier to their flight. But I have found that in almost every case where the streams seem to limit the distribution of plants their seeds are not such as would be carried by birds. Those of the dogwood are winged; of the crabwood, Bejaria, Ceratiola, and some others are contained in capsules and the Lysiloma bears beanlike seeds in pods. Probably nearly all of these are eaten by birds but the seeds are of the digestible sort.

Of course climate acts as a check to the northern or southern distribution of many forms, there being a limit of heat or cold which they cannot endure, and these climatic boundaries seem to be sometimes coincident with the watercourses.

Finally, there are the adventive plants, the wanderers, of which we have, as yet, comparatively few species; but later, when the country is older and more generally cultivated, there will surely be an army of them. The railroad beds are regular propagation gardens for foreign plants, but not always of a helpful kind, for trains bring in seeds which, for the most part, belong to injurious or objectional species. Others come on clothing, in automobiles or steamers, the latter bringing most of our exotic plant tramps. Some of these are the vilest weeds; a few have no decided characters for good or evil and one or two are beneficial. The sand burs (Cenchrus), beggar's ticks (Bidens), and the Boerhaavia, with oval crimped leaves and airy panicles of minute purple flowers, are not only undesirable weeds but they all bear the meanest kind of burs. Our northern fleabane (*Erigeron canadensis*) is beginning to creep in, so are the ragweed (Ambrosia), the common purslane (Portulacca), and a couple of Chenopodiums. The pepper grass (*Lepidium virginicum*) is getting to be common along the roadsides and it is a not unwelcome immigrant with its pleasant, pepper-tasting pods. The rapidity with which some of

these introduced plants spread is amazing. Let a new road be opened through the virgin forest and sand burs, beggar's ticks, Sidas, and Sporobalus—the latter a useless grass from India—will form a border along it in a single season. I elsewhere mention the beautiful Natal grass (Tricholæna), which is coming in rapidly and promises to be a valuable forage plant.

Not far from my home is an extensive rock pit which has been abandoned over a year. It is located in the pine woods at some distance from any habitation or road, save the one over which rock was hauled away. Within it I counted more than sixty well-established species of plants, over one third of which were adventive. The seeds had been wind-borne; rains may have washed in a few; wild animals and birds had carried some more, and doubtless some had been brought by the teams and wagons that did the hauling.

In the parable of the sower some seeds fell by the wayside and the fowls devoured them; some were cast on stony places to wither and die. Other seeds were sown among thorns and were choked, but still others fell in good ground and brought forth thirty, sixty, even an hundred fold.

So it is with nature's planting. Millions of seeds of dry-land plants are washed into swamps and other millions of those of marsh plants are transported to dry ground. Others are thrown on rocks or upon salty sand dunes only to die, while countless others perish from cold, insects, and numberless causes. But those of the noble pines, the saw palmettos, and of the trees in the glorious hammocks have certainly fallen into good ground and have brought forth thirty, sixty, and even an hundred fold.

CHAPTER VIII

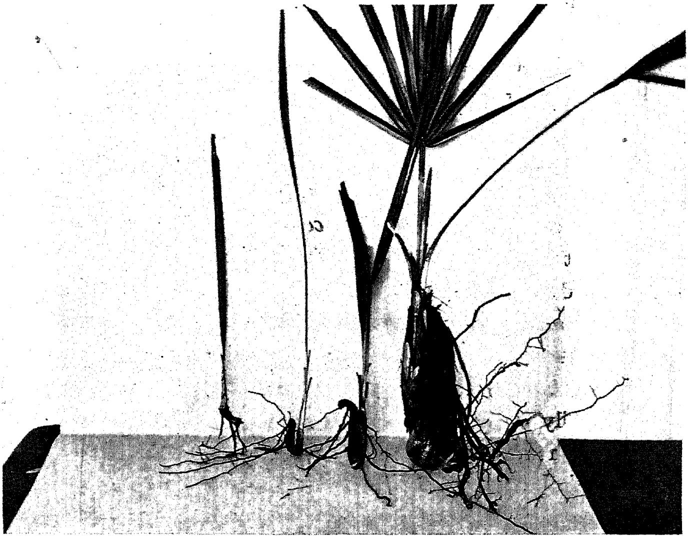
The Lure of the Piney Woods

TO most people our pine forests are monotonous to the point of dreariness, for there is an endless repetition of a single form of tree until the eye wearies of it. Along our eastern border the ground is covered with two species of low-growing palmettos, three or four of small oaks, and quite a variety of shrubs and herbaceous plants. A thorny, woody smilax creeps over much of it, often binding the vegetation together until it is impossible to penetrate the dense growth, and it sometimes climbs well up the pines. In the same part of our region a small palmetto is also found on the rocky ridges in considerable abundance. This is known as the silver palm (*Coccothrinax garberi*), a lovely species with rich, glossy, deep green leaves having a wonderful satinlike under surface. Here and there are lofty, gaunt dead trees with crooked,

ragged limbs, decidedly striking and picturesque, but not at all beautiful. These dead pines are the favorite resorts for mocking birds, from which lofty perches they pour forth their clear, strong music.

It might indeed seem that there could be neither interest nor beauty in so desolate a region, but to him who has eyes and ears trained to see and hear and whose senses are responsive to Nature's less clamorous appeals the pine forest teaches some fascinating lessons. Here, since the land was elevated above the ocean, a constant battle has raged for place and for the chance to live and reproduce.

It is probable that shortly after the first elevation of our area in Pleistocene time the seeds of our common pine (*Pinus caribæa*) were deposited on the higher land and the forest established. The seeds are winged and are carried to considerable distances by strong winds. It is commonly supposed that ours is the same as the Georgia pine, but though closely related and resembling it, it is really different. This tree is the Caribbean or slash pine. It inhabits the Bahamas, several of the West India islands, Central America, and, in the United States, the southern end of Florida and



Upper View. Pine Woods near Home of the Author

Photo by Prof. F. G. Smith

Lower View. Different Stages of Growth of Dwarfed Cabbage Palmetto (*Sabal palmetto*), Plant on Left Just Beginning to Bend Over; Second Plant Having Formed a Loop; Third Plant Beginning to Show Character Leaves; Fourth Plant Fully Developed

the coasts to Louisiana and South Carolina. Whether our stock came originally from the tropics or developed from the long-leaved Georgia pine I cannot say.

As soon as the pine forests were established in our region, seeds of palmettos and of many species of shrubs and herbaceous plants found their way in and germinated, until the ground was densely covered with undergrowth. As old trees died conditions became perfect for a conflagration. During a dry time some dead tree was struck by lightning and set afire. In dead pines the sapwood becomes very light and corky and burns slowly like punk, retaining fire a long time. The bark burns more readily and with the decaying sapwood easily falls off. The heartwood underneath is a mass of pitch, ready to flame up in an instant and once started it burns for a long time with intense heat. On the ground under the tree there is usually a lot of highly inflammable dead bark and rubbish and the palmettos everywhere about burn like oil. Once started an all-consuming relentless fire is certain to rage through the forest, progressing by leaps and bounds if there is a strong wind.

No doubt the first conflagration that raged through the lower Florida pine woods wrought terrible havoc and many species of plants were completely destroyed. Of some perhaps a few specimens in places less exposed to the heat survived. Since the pines have lived in fire-swept areas from the very first, many young ones must necessarily have escaped fatal injury, and the same must be equally true regarding other plants living in such situations.

Undoubtedly lightning fired the forest long before human beings inhabited the region. Then came prehistoric man, later the Indian, and at last the Caucasian. At all events it is almost certain that from the very beginning of the forest, fires have swept through it at intervals of a few years. I have seen such fires during a drought period rush through the pines before a furious wind with the speed of a horse. The fire leaps to the tops of the tallest trees and with a hissing burst of red flame consumes their leaves. Young pines fully eight inches in diameter may be killed outright. All herbaceous and shrubby vegetation is instantly devoured, including the oily leaves of the palmettos; only their charred stems are left. Large

trees, apparently sound and healthy, but having some dead or weak spot in their trunks, are toppled over and destroyed.

It must be evident that no plant of any kind can live through such an ordeal without extraordinary luck or some special means of protection. The bark of the pines is very thick and is likely an excellent non-conductor. The leaves are long and clustered around the buds; although they contain resin they do not burn readily, and often under the heat of an *ordinary* fire they are scarcely singed. I have seen young trees not a foot high, over which a fire had recently passed, the outer leaves of which looked exactly as though they had been scalded, while the plant itself was wholly uninjured.

In what is called the Homestead country the pine forest consists of tall, slender, straight trees, of rather small size and set closely together. They look so different from the trees of the Miami region that they are quite commonly supposed to be a different species. The reason for this difference in appearance is because in Lower Dade comparatively little undergrowth exists on the very rocky forest floor, hence the fires are much more

moderate and but few young pines are destroyed. As a consequence they are slender and straight and grow closer together. In the Miami area, on the contrary the ground is covered with dense undergrowth and most of the young pines are killed. The few that do survive form an open forest and with room to grow they become large, rugged, and gnarled.

Anyone inspecting a pine woods after a severe fire would be certain that every vestige of vegetation was utterly destroyed. Nothing is left but a few burnt stems; blackness and desolation are seen on every hand. With the exception of some larger pines everything seems to be dead. But visit the forest a fortnight later and young tender growth is springing up everywhere. Grass is peeping through the ashes and charred debris and little green leaves are smiling amid the ruins. Look carefully at the bases of small oaks and other shrubs and see the young shoots beginning to grow just at the ground or a little below the surface. Now the *vital part* of all these plants is safely hidden *below* the surface of the earth. This is the lesson which has been forced upon the dwellers of the inflammable pine belt,—a lesson that

cost many thousands of lives in the learning. The plants of the pine woods *must bury all that is essential to their existence down where the heat cannot injure it, or if it is above ground it must be fire-proof!*

Some of these plants have thick underground stems, such as the comptie (*Zamia floridana*), with its large parsniplike roots. It is a diœcious plant, blooming in winter and spring, just when the forests are most subject to fires. It probably cannot change its period of blossoming to a less dangerous season but it has developed an efficient device for protecting its flowers and fruit from the fire. These are contained in a large reddish brown cone, the outside of which is padded with thick, velvety, peltate plates with the edges set closely together; each is supported by a stout stem springing from the central one. The flowers are attached to the inside of these plates and when they develop the latter spread a little apart to enable the necessary exchange of pollen. At the time of blooming, if a fire sweeps the forest these thick plates close tightly together. They are doubtless excellent non-conductors and as the cones are close to the ground it is rarely they suffer fatal injury.

When the large, oval, indigestible seeds ripen and fall to the ground they are covered with a lovely orange or scarlet pulp enclosed in a glossy sac. This bright color attracts gophers and various small wood animals and possibly certain birds that relish the pulp. Thus a means of distribution is also provided.

This plant is a very old-fashioned one. It is in fact a member of an order (Cycadaceæ) which belongs to the distant past. The group first appeared in the Devonian and reached the apex of its development in the Mesozoic, when these plants were so abundant that the period is sometimes called the "Age of Cycads." From then on, the order decreased until now only about a hundred species exist, all inhabiting the warmer parts of the earth. The leaves are pinnate, usually rolled up when young and uncoiling as they develop, after the manner of fern fronds. The stamens and pistils are nude, there being no other parts to the primitive flowers, and finally the seeds are destitute of envelopes. Two species of the order inhabit Lower Florida, *Zamia pumila and Z. floridana*, and both have the seeds attached to the inside of shieldlike plates as just described.

In order to protect itself from the fires the saw palmetto grows in an almost absolutely prostrate position, often with the lower half of its stems buried in the ground. The upper or exposed parts of these stems are so thickly covered with "boots" (the bases of the old leaf stalks) that fire cannot harm them. Only the growing point turns upward and it is protected by the bases of the living leaves and an almost fireproof netting. In the pine land along the borders of swamps these palmettos reach a great size and length, their growing ends always pointing in the direction of the low land. As they push on along the ground they often fork and crawl over or under each other. This can best be observed after a severe fire, for then all the other vegetation is burned away. I never look at them at such a time without fancying that they are a lot of sleeping alligators, their scaly backs completing the illusion, and I half expect to see them wake with the slightest noise and rush into the swamp. In the lowland, where there is practically no danger of fire, this palm usually grows half erect, and in wet ground it becomes actually treelike, attaining a height of fifteen feet.

The silver palm has the growing bud closely covered not only with the bases of the leaves but also with a strong netting of clothlike fiber for the purpose of supporting the young foliage. This fiber is almost as fire-resistant as asbestos. The trunk—for it sometimes becomes a small tree—is covered with a hard, corky thick bark, which also furnishes an excellent protection against heat.

One of the most interesting plants of the pine woods is a stemless palm with stout leaf stalks and heavy, fan-shaped leaves having midribs strongly recurved (*Sabal megacarpa*). It begins life like any ordinary palm by sending up a few slender, entire leaves. Then the base of about the third leaf bends back into the ground and then suddenly turns upward, forming a blade above the ground. The lower part of the next leaf in like manner turns, going still deeper into the soil and then ascends. About this time the little stem abruptly changes its direction and grows almost vertically back into the earth, leaving a blunt stub at the point where it turned. As the plant grows the stem goes deeper and deeper and the leaves come up from the buried point, the stem always re-

maining well below the surface. It sends up flower stems which under favorable circumstances reach a height of four or five feet.

In other words, this strange plant begins life as an ordinary palm, just as though it were going to become a tree, but at an early stage of growth the elongating trunk turns and grows the wrong way; *it actually backs down into the earth until it sometimes reaches a depth of sixteen inches*, and only sending up its leaves and flower stems above the ground. Ordinarily the growing point is eight inches to a foot below the surface. In grubbing new land this big stem, filled with starchy matter, is not reached at all with the grub hoe. The leaves are cut but new ones constantly spring up, and in order to kill the persistent plant an iron rod must be thrust down into the growing bud and a little kerosene poured in. If fire is kept out of the pine woods for several years these same palms, with confidence inspired, begin to grow into trees. This is especially true where they are left standing in cultivated ground. *In such cases they soon form a strong, erect trunk and develop into the ordinary cabbage palmettos!*

This strange habit of growth is but a device to

protect the plant from destruction by fire. Of course, the very young seedlings are in some danger before they can burrow into the earth but they usually come up during the rainy season, when that risk is very slight. As a baseball friend put it, "they beat it to first" before dry weather comes on. This palm has been made a species separate from the ordinary cabbage palmetto partly on account of this peculiar manner of growth. It is only a depauperate form of that tree with an abnormal growth habit wholly the result of unfavorable environment.

As further evidence of this special adaptation to fire, one may find in the edges of the hammocks, where the danger from fire is greatly lessened, plants with *flattened, prostrate stems,* and a little farther in, the same plants *rise at various angles.* Still deeper in the hammocks I cannot separate them from the ordinary cabbage palmettos. This strange reversed growth is seen in a number of our cultivated Sabals and in a few other palms, showing that they also have had to defend themselves from fire in their native prairies or savannahs. The dwarf Sabal has larger seeds than the cabbage palmetto, a fact also used as a character in separat-

ing it specifically from the tree form. It is well known however that the seeds of many depauperate plants are larger than those of well-nourished specimens. For example, *Ximenia americana* grows in our pineland and hammocks; in the former as a low, stunted shrub where it is burnt off in every fire, but in the latter as a slender tree where it is protected. It has a yellow drupe, larger on the stunted half-burnt bushes than on the well-developed trees. However loath I am to reduce our list of Florida palms it seems necessary to strike this one from it.

A forest fire at night is a most impressive and terrible sight, especially if it is fanned to fury by a high wind. Great masses of detached flame leap to the very tree tops. There is an incessant crackle and popping as the palmetto leaves catch, with now and then a report like the firing of a gun. The blaze rushes up the trunks of the trees, often into their crowns. An occasional pine once injured, though apparently healthy, may have from a scar an ooze of pitch clear down to the base of the stem. This the fire attacks with inconceivable fury. Within the scar the wood is usually decayed, and soon the doomed tree falls with its

green head to the blackened earth, "dying with its boots on," as one might say.

The fire sweeps on, now over one of the low, rocky ridges, and is rushing through the lovely silver palms. Their leaves are crackling like the roll of drums but their stems withstand the onslaught. Although sadly disfigured they really come through the ordeal as safely as did Shadrach and his friends from the fiery furnace of old.

The tall dead trees are ablaze the instant the flame touches them, and if the weather is dry they may continue to burn for weeks, in which case they stand as pillars of fire by night and of cloud by day. These fires destroy nearly all the vegetable humus on the forest floor and about all that is left of it is some ash. The soil is thus kept very poor and thin and to some extent this prevents the hammock vegetation from getting a foothold. Roland Harper and E. F. Andrews have shown that were it not for the forest fires the long-leaved pine (*Pinus palustris*) would be driven out by other growths, and I am sure this is also true of our Caribbean pine.

Some of the small oaks which inhabit the pine forest would become arboreal but for the fact that

they are usually burnt off about the time they begin to assume treehood. One of these is only a shrub at best, as it rarely attains a height of a couple of feet. Yet it bears fine, dark-colored acorns sometimes three quarters of an inch in diameter, and the crop is occasionally so heavy that the little stem bends under the load. It is the *Quercus minima*, most aptly named, and having spiny leaves like those of holly. This species is one of the smallest of the genus while the live oak, common throughout our territory, becomes under favorable circumstances our largest tree. Specimens sometimes have a trunk diameter of five feet, and one of them in the Paradise Key hammock has a crown that measures two hundred and eight feet across.

Among the herbaceous plants found in the pine woods is a slender, unarmed vine so abundant in places that it completely covers the low scrub. It looks much like one of the dodders common throughout the temperate parts of the United States. Its leaves are but minute scales, its whitish flowers are in small clusters; it grows in dense mats; it is a parasite. The dodders have all these characters but are unrelated to our creeper. Ours is a bo-

tanical celebrity and a veritable globe trotter. It grows all over the warmer parts of America, Polynesia, Asia, Africa, and Australia. Formerly placed by botanists in the Laurel family, now, perhaps on account of its notoriety, it is made the representative of a separate group, the Cassythaceæ, and ours is the *Cassytha filiformis.* The fruit is a sort of drupe eagerly devoured by birds, and the hard, indigestible seeds are thus dispersed. The whole fruit is also very buoyant, keeping its vitality a long time in salt water, so it has two very efficient means of distribution. Its seeds usually fall to the earth and germinate after the manner of ordinary seeds, and the vine itself sometimes lives out its life as ordinary normal vegetation does. But if any weeds or shrubs grow near it the little Cassytha vine creeps towards them along the ground until it can lay hold of one of their stems and begin to twine up it. As it does so it emits little rootlets which penetrate the host and draw the already elaborated sap from it; thus it changes into a true parasite, and the main stem which connects it with the ground, now useless, decays. The growth of the dodders takes place in precisely the same manner.

In the higher, drier parts of the forest one occasionally sees low, sandy mounds from one to two feet high and ten to fifteen feet across. For a long time I was uncertain as to what these were, though I felt sure they were artificial. I had seen gopher mounds up the State which somewhat resembled these but I was unaware that this animal came so far south. I was also puzzled to account for animal burrows in almost solid rock. One day I found that I could thrust a sharpened iron rod down four feet anywhere in one of the mounds and, indeed, for some distance around it. Another time I found a large dead gopher in the pine woods near my home. This is not the animal which bears that familiar name in our western states but is a large land tortoise (*Xerobates polyphemus*) which has very strong forelimbs to enable it to excavate its immense burrows.

The mystery was solved; the gopher is a resident of Dade County. Since then I have seen its mounds in other places in the neighborhood of Miami and also at Cape Sable. As a rule the limestone in this region comes to the surface and the only sand to be found is that which fills the pot holes. At long intervals solution has been so

great that depressions have been formed which filled with sand at the time of the filling of the many pot holes. It is in these "sand seeps," as they are called, that the gopher makes its home in our rocky pinelands. But how can the creature find these sand seeps, for to all appearances the forest floor, covered with dense scrub, is everywhere alike? It must have the guidance of some special sense which distinguishes between rock and sand hidden beneath the surface.

Bartram writing of this tortoise in 1791 said: "When arrived at its greatest magnitude the upper shell is near eighteen inches in length and ten or twelve in breadth." Mr. H. C. Hubbard has excavated several of their burrows near Crescent City, Florida, and finds the galleries eighteen to twenty feet long in the sandy ridges remote from water. They descend in a straight course at an angle of 35°, terminating abruptly at a depth of eight or nine feet below the surface. He states that after excavating several feet he found the walls fairly alive with a wingless cricket of the genus Ceuthophilus. Farther on he found immense numbers of larvæ and imagoes of a small beetle, and in all he obtained no less than thirteen species

of insects living with the gophers, of which seven proved new to science. All of these are strictly subterranean in habit; with them is sometimes found a toad. How little do we know of the lives of most of the wild creatures! They all have interesting life histories, but alas! many of them are already extinct and others soon will be.

The rocky floor of the woods is exceedingly rough and irregular, in fact it appears in places as though it had been dynamited in every direction. The surface consists of loose masses of rock of all sizes up to pieces weighing several hundred pounds. This is mixed with a small quantity of soil, sand, decaying wood, and other vegetable debris; the whole, perhaps, thinly overgrown with grass and low plants. In such a foundation the roots of the pines can obtain at best but an insecure hold, even though they begin their existence in the depressions or pot holes. While it is not possible to drive a tap root into the solid rock, yet they can push their powerful laterals sidewise through crevices in the more or less disrupted strata. These slowly heave the rock loose, especially when aided by the high winds and hurricanes which sway the trees. The more the rock

is loosened the further the roots penetrate. So in time the tree becomes elevated on a sort of rocky mound and as it grows old its foothold becomes more and more insecure. The prevailing winds in this region are from the southeast and as a consequence a majority of the trees, especially near the sea, lean more or less in a northwesterly direction and the greater part of them fall in the same way. In time of hurricanes they may of course fall towards any point of the compass.

Whenever a tree falls its roots pry up a quantity of rock and some soil, setting the mass on edge. Sometimes the bole is lifted as much as ten feet or more and a hole is left where the roots grew. By and by the tree decays or is consumed by fire and nothing remains but an irregular mound and a corresponding depression beside it. Other trees grow up to repeat at last the mound building and excavating process. Thus in time the floor becomes indescribably rough and uneven.

The trees and the storms are thus acting as a great plow to break up the rock and turn it over in these rough and irregular furrows; the rains dissolve it, and year by year a small amount of decayed wood and humus collects in the depressions.

Upper View. Uprooted Pine Showing Conical Mass of Roots Raised above Level of Rocky Floor

Lower View. Uprooted Pine Showing Mass of Rock Torn up by its Roots

Both from Lower Dade Co. and Photographed by Dr. John K. Small

Could only fire be kept from it the floor of the piney woods would soon be covered with a thin but rich soil and the hammock growth would creep in.

In some parts of the forest there are parallel rows of young pines, the two being some five or six feet apart and one naturally wonders how they came to be planted in this regular fashion. In such places a wood road formerly existed of which no trace remains. In the middle of it the palmettos and other low vegetation were probably not entirely killed but along the wheel tracks they were completely destroyed. The old tracks when abandoned then became admirable seed beds for the pines. I have seen such trees a foot in diameter, still showing the row formation.

So the battle of the forest goes on year in and year out through the long centuries, a strife between the different types of vegetation for a place to live and a chance to multiply. On the other hand the fire, like a well-equipped and completely disciplined army, is the inveterate enemy, and it is always ready to take the field at a moment's notice.

Such are the piney forests of Lower Florida,

and to him who is in harmony with nature there is nothing more alluring in all the land. No more attractive place for the botanist can be found, for its floor is the meeting ground for hundreds of small tropical plants and for many others of more northern habit. Here are always beautiful, odd, and interesting things in blossom and they present a succession of rich color throughout the year. There are many beetles, diptera, and orthopters, while butterflies abound, especially along the sunny borders between pineland and hammock. During times of abundant rain immense numbers of small land snails of several species may be found on or under the loose rocks, or even venturing for a short distance up the trunks of trees.

Here the forces of nature are always active; here is life of the most virile type; here birth, growth, death, and extermination are in constant operation side by side. Here are some of nature's most wonderful devices for protection against the constant menace of the destroyer—fire; here are some of the clearest examples of the survival of the fittest.

The scientific wonders of the pinelands are not their only lure. Notwithstanding the monotony

of the forests they possess an indefinable charm and beauty, and over all is a wonderful and wholly indescribable atmospheric effect—a soft, evanescent half haze, half glow, peculiar to Florida, seen only at its best in the piney woods. Here the partial shade of the pines and the brilliant glare of the sub-tropical sun are merged and mellowed into a softly glowing light. In every direction are the straight, brown trunks of the trees, sharply defined in the foreground but fading in the distance until they blend in the haze and become a mighty brown curtain. This wonderful atmospheric effect is not that of the northern smoky Indian Summer. It is more dreamy and ethereal. The very *essence* of Florida's soft and gentle climate seems to have descended upon and enchanted the forest scene.

CHAPTER IX

The Origin of the Hammocks

IF fire that sometimes destroys them is in the end the friend of the piney woods of Florida, it is uncompromisingly the enemy of the hammocks. If there were no forest fires the dry pinelands would soon be captured and occupied by hammock growth. I believe that no hammock originates (in Lower Florida at least) where there is not some real protection from forest fires.

The word "hammock" is generally applied in Florida to the forests of broad-leaved trees as distinguished from pine woods. There are several kinds of hammock in the State; in our part we have "high" and "low" hammocks and each may be rocky or not. We also have "heavy" hammock, consisting of tall, straight trees closely huddled together, and "scrub," in which the dense growth is low and tangled. On the keys and along the

southern edge of the mainland the vegetation of these hammocks is mostly tropical; over the balance of our area it is a mixture of tropical and warm temperate growths, or almost wholly temperate and warm temperate. The vegetation of the swamps and lowlands is less tropical than that of the corresponding uplands, probably because the soil in the two former is colder.

The majority of the fruits of our hammock trees and shrubs are either berries or drupes (plum-like). Generally these are attractive in color and are greatly relished by birds. In fact they constitute for many of them their chief food, and a hammock, in any region, always attracts great numbers of birds. In eating the fruit they swallow the seeds as well, which are passed out undigested and with their vitality unimpaired. Thus they are scattered broadcast in every direction—in the pine woods, the swamps—everywhere. So, then, the birds become horticulturists and are responsible for the dispersal of many of our plants. Nature has drawn up a contract between these little farmers and the trees. The latter must have their seeds distributed and planted elsewhere to maintain and spread their species and to form new

colonies, but they have no means of their own of sending forth their seeds. So they resort to this clever device; they cover their indigestible seeds—which the birds would never touch—with a coating of succulent, nutritious pulp and they paint the dainty morsel a bright, attractive color and then say to the birds: "If you will plant our seeds for us off at a distance we will pay by giving you some delicious fruit." The offer is accepted and the contract is faithfully carried out on both sides.

Although the soil in the pine woods is poor and the ground is generally covered with low vegetation, a number of hammock plants would grow in it and become trees if they had half a chance. Near my home, where there has been no fire for several years, the following species of broad-leaf trees have appeared among the pines and some of them have reached a height of ten or twelve feet: *Ficus aurea* and *brevifolia*, the wild figs; *Trema floridana*, a short-lived tree and one of the precursors of the hammocks; *Quercus virginiana*, the live oak; *Dipholis salicifolia*, bustic; the poison wood, *Metopium metopium; Pisonia obtusata* or blolly; *Pithecolobium guadelupensis;* gumbo limbo

Upper View. Very Young Hammock in Pine Woods near Residence of Author
Photo by Prof. F. G. Smith

Lower View. Young Hammock at Water Hole on Long Key, Everglades
Photo by Wilson Popenoe

(*Bursera gummifera*); marlberry (*Icacorea paniculata*); prickly ash (*Zanthoxylum clava-herculis*); sweet bay (*Persea borbonia*); *Forstiera porulosa; Lantana involucrata*, a large shrub, usually confined to the hammocks, and *Rapanea guianensis* or myrsine. To my surprise *Ilex cassine* and *Baccharis halimifolia*, two shrubs or small trees which ordinarily grow only in low ground, were also found here. The bayberry (*Myrica cerifera*) is common in low land, where it often becomes quite a tree. A form of it grows in the pine woods and here it had reached a height of five feet. *Ximenia americana*, sometimes called hog plum, grows in both pine and hammock land; in the latter as a small tree, in the former as a low shrub. Here it was six feet high.

The new hammock growth here is so dense that one entering it is at once concealed and lost to view. This demonstrates well enough that the poor thin soil of the pine woods is able to support hammock trees and also that there is no lack of planting. Usually the more abundant and vigorous hammock growth is on the rocky ridges and not on the level land. The ridges are freer of other growth and offer more room, and fires are less

severe upon them. Everywhere the Pithecolobium is by far the most abundant shrub in the incipient hammock, and the live oak is perhaps a close second. A thorny shrub belonging to the coffee family, *Randia aculeata*, having small, glossy leaves and pretty white flowers, is very abundant on the rocky ridges where young hammock is forming and in the old-established forest south of Miami it becomes a genuine tree. I have seen a number of other examples where hammocks began to develop in pine woods less subject to fire.

On islands, where the fire risk reaches the minimum, hammock growth usually takes undisputed possession. This is equally the case on peninsulas. Throughout much of the territory from Miami southward the floor of the pine woods is of that exceedingly irregular, ragged limestone already described and upon it the hammock growth is forever seeking lodgment but the fire is sure to come sooner or later. These incipient hammocks in such exposed, thin-soiled regions never progress beyond the stage of dwarfed shrubs.

Near the extreme lower end of the mainland the rocky surface is elevated only two or three feet above ordinary high tide. Everywhere are count-

less water holes and shallow pits that either contain water or are always moist. Over much of this area hammock vegetation has taken a firm hold and though not exempt from occasional fire toll, yet by reason of the moisture and the partial protection of the surrounding rocks it is never wholly destroyed. Here is a list of the more abundant trees and shrubs found in this low, rocky pineland.

Annona glabra, pond apple.
Chrysobalanus, coco plum, two species.
**Trema floridana*.
Diospyros, sp. persimmon.
**Quercus virginiana*, live oak.
**Metopium metopium*, poison tree.
Bursera gummifera, gumbo limbo.
Ficus aurea, wild fig, strangler.
Cephalanthus occidentalis, button bush.
**Callicarpa americana*, French mulberry.
**Icacorea paniculata*, marlberry.
**Myrsine rapanea*, myrsine.
Persea palustris, sweet bay.
Ilex cassine, yaupon.
Ilex krugiana, holly.

Guettardia elliptica, velvet seed.
**Guettardia scabra*, rough velvet seed.
**Myrica cerifera*, bayberry, wax myrtle.
**Byrsonoma lucida*, locust berry.
**Tetrazygia bicolor*.

Those marked with an asterisk are the pioneers or precursors of the hammocks and indicate the trees and shrubs which originally start the forest, and also that live on their outskirts and accept the brunt of battles with the fire.

A good many hammocks originate on the bay shores, along the open sea, by streams, ponds, and swamps. Most of the others develop beside the deeper limestone sinks in the pine forest.

I have already described the sandy and rocky ridge lying near the southeast coast of the State, and how near Florida City it turns to the westward and is broken into a long chain of "islands." In the lower part of this ridge are numerous sinks, or "banana holes" as they are locally called, that vary in size from an ordinary pot hole to a quarter of an acre in extent; they may be partly filled with standing water. In the pineland these sinks are surrounded by rank, coarse herbage and it is

among these moist depressions that young hammocks are developed. They range from a few lonely struggling trees and shrubs to very respectable forests of several hundred acres. It is the best place for studying hammock development, for here may be clearly seen every step of its growth from the very start to the completed and finished forest.

The banks of the "banana" holes or sinks may be steep, or sloping and on these damp walls herbaceous vegetation grows lushly and by its decay gradually forms a little soil. This prepares the way and thereon the hammock usually begins its career; the first to grow and become a real tree is generally a live oak.

This tree is the Achilles of the hammocks. It is found always in the very front of the firing line, a determined and courageous fighter. Its small acorns must be carried by forest animals and in the *beaks* of birds, for they are perfectly digestible. One of these reaching the sloping bank of a sink and finding some soil at once germinates. The steep wall of the water hole partly shields it from the fiery implacable enemy. One of the most rapid growers among our native trees, if

spared a few years from fire it reaches a height of several feet and displays a goodly spread of branches. At this stage of its growth a fire will scorch or may destroy its top, but it is not likely to kill it outright. Although crippled and handicapped it continues to grow and in time its foliage begins to shade the ground. This shade is the first blow against the pines the hammock seeks to supplant. It is as deadly to the pines as the Upas tree to the forests of Java. Now these oaks have low, rounded heads and the limbs reach close to the ground. A tree in the pineland near me about thirteen years old has a trunk twenty inches in diameter and a low, dense crown fifty feet across. Such trees cast a deep shade and prevent the light-loving young pines from getting a start; they also rob the soil of its substance, making it difficult for any other vegetation to grow beside them.

This oak must be a veritable salamander, for it emerges almost unscathed from fires which would destroy any ordinary tree. Even its leaves are nearly fireproof. When they fall they lie flat on the ground and the strongest heat will scarcely singe them.

In the meantime another oak or two has likely

made a good start which with some lesser vegetation aids in the fight for the conquest of the pine forest. *Trema floridana*, descendant of a closely related West Indian species, soon appears on the scene. It is a small, soft-wooded tree with orange-colored berries, which are relished by birds, is of no account whatever and appears to be just the thing to burn, which it often does. It has, however, its part to play, for growing thickly and rapidly it overcomes and kills the palmetto scrub and other low vegetation opposing the hammock extension. Then comes the poison tree (Metopium) and a right good fire fighter it is. Myrsine and marlberry arrive and become abundant in the expanding young forest. They grow close together and shade the ground.

Given now a few years with no bad fire to cripple it our fledgling hammock will have pushed rapidly out into the pine forest. The pines do not flourish in the hammock; they retire before it as does the Indian before the white man. When I came to my home sixteen years ago a solitary slender pine grew in my hammock. It is still alive, but although I have cleared away around it, it does not grow and it is not healthy. Occa-

sionally one does see fine pines within a hammock but it may be taken as an indication that the hammock is spreading rapidly. Once it is established it relentlessly chokes out the young pines, even if their seeds do germinate in it, for of all trees they must have abundant room and direct sunlight in order to flourish.

After the pioneers are well fixed and strong and the ground has become more shaded and a thin soil of leaf mold is forming, then new types of hammock trees enter. The gumbo limbo (Bursera) is one of these second migrants and so are some of the Eugenias or "stopper" trees and a number of others. The saw palmetto in the way of advance is soon killed and the curious dwarf Sabal already described as so common in the pine woods, now captured and surrounded by the advancing hammock, develops into the true cabbage palm and in its congenial station reaches a height of forty or fifty feet. It is a royal good fire fighter too and a valuable ally—although a traitor. Here is a case of a soldier who fought bravely with the enemy but who, now a prisoner, turns about and fights as valiantly against his former comrades. Ferns and Bormeliads next establish themselves

on the trees and the young forest begins to take on the appearance of a fullfledged hammock.

I believe that under favorable conditions the hammocks develop very rapidly. Partly surrounding a sink on Long Key, in the Lower Everglades, is a young hammock of about an acre in extent, consisting mostly of live oaks. On the bank of the central water hole a dozen pine trees formerly stood—trees which had probably completed their growth before the hammock started, and which were doubtless killed by the incoming live oaks. They had finally fallen with their heads dipping into the water. At the time of my first visit to this place the bark and sapwood of these pines were completely decayed, but the heartwood was sound. The fact gives a clew—or even the positive evidence of the age of this hammock. It could not have been over fifty years, probably less than half that.

At the time of my first visit to this young hammock, my neighbor, John Soar, Wilson Popenoe, of the Department of Agriculture, and I took a two days' tramp over Long Key to botanize and explore. We left our impedimenta on the bank of the pool where we intended to camp. When night

fell, we gathered some dead pine wood,—"light-wood" or "lightered" as it is called—and built a fine fire. After a cold supper and some yarns we tried to rest. The mosquitoes were bad; the sharp uneven rock like Banquo's ghost murdered sleep. The sky was overcast, the wind southwest, and we realized a norther was coming.

With a good deal of badinage about adjusting ourselves to our rocky beds and regarding the friendliness of the insects, we finally rolled into our blankets but not to sleep. The wind suddenly whipped into the northwest and a cold, steady rain began to fall. Soaked through, but with our blankets wrapped about us, we sat around our weakening fire and "made a night of it." Soar, who is an old settler, told delightful stories of early days in Lower Florida and of many trips such as we were now taking. Popenoe, though only a boy, is a globe trotter and regaled us with reminiscences of adventures in Brazil, in India, and in Guatemala, and the old man attempted to contribute his quota to the general fund. Congenial men can draw very near to each other under such circumstances, and although we were cold, wet, and half devoured by mosquitoes, though our

environment was the dreariest imaginable, the memory of that night at the little hammock is one of my very pleasantest.

As soon as the trees and shrubs in the embryo hammock begin to bear seed, its growth is greatly accelerated. The open spaces fill. The borders advance. Ordinarily the fires in the pine woods expire at the edge of the hammock, or only burn a little way into the scrubby, more open parts of it. The wood and leaves contain very little resin or other highly inflammable material. But some day during a long, severe drought and when driven by a high wind, the ravening enemy comes rushing through the pine woods resistless. The natural moisture of the hammock is dried out, the leaves are wilted and gasping for water, the dead timber, standing and fallen, is like tinder. The flames rush into the forest almost unchecked, snapping and roaring their battle cry. Noble trees clad in garments of glorious foliage are stripped in a moment and left mere blackened and ruined trunks; all the wonderful decoration of orchids, ferns, bromeliads, and scrambling vines is devoured in the twinkling of an eye. No words can describe the awful wreck; there is in all the

world no more sudden and terrible change from beauty to hideousness than is this. If the leaf mold which forms the forest floor becomes ignited and burns to the rock below, then indeed the rout is complete and all is killed. If not, then the paralyzed, prostrate victims may recover.

Enter this ruined forest two months later and green, fresh leaves and young growth will be peeping out in many places. Even some apparently dead trunks will be thrusting forth new foliage and branches. In one season the hammock begins to regain some of its lost beauty, although the cruel fire marks are still there. New Bromeliads and other epiphytes will be found on the dead trees; vines will scramble over the charred trunks, in places well nigh screening their ugliness from sight. In ten years the ground will be fully covered with growth and the uninitiated would not suspect that fire had ever ravaged the spot. So the struggle goes on year after year and age after age between the vegetative forces and the fire, but I am inclined to believe that before the advent of the white man the hammocks were getting the best of it.

In places along the fire-swept edges of the ham-

View on Paradise Key; Royal Palm Hammock

Photo by Harrison's Studio, Miami

mock the broad-leaved growth has been entirely exterminated, and one can only know it for an ancient hammock site by the presence of half burned or decayed logs, or by broken fragments of the tree snails scattered on the surface or buried in the ground. Rarely a small hammock may be found on high land which has no sink or depression as a nucleus, but the few I have seen were near other larger hammocks and doubtless had been cut off from them by fire. The damp hammock sinks instead of being overgrown with coarse vegetation, as in the open pine woods, are made ravishingly beautiful by the ferns and other shade and moisture loving plants that occupy them. No words that I can summon will properly describe the wonderful effect produced by these fern gardens. The ferns often scramble up the tree trunks, covering them with a [illegible]e mat to a height of several feet. Here is [illegible] the only tree fern of the United States, [illegible]*teris ampla*, with richly cut fronds spread over a space of a dozen feet and supported on stout trunks two feet high. The walls of the larger sinks are often covered with elegant halberd ferns and from among them spring immense tufts of

maidenhair which droop over the pools with wonderful grace. There are also a fine holly fern; several strap ferns on the decaying logs, grass and serpent ferns on the cabbage palmettos and the resurrection fern that clothes the leaning trunks and branches of the live oaks. But the real glory of the hammock is the two species of Nephrolepis, one being the well-known "Boston" fern. These are often found on trees, especially the palmetto, but they also grow over the floor of the forest forming masses higher than a man's head and sometimes so dense that one may walk over them. The fronds of one of these measured over twenty-seven feet in length!

In many places young hammock grows on ground so rocky that the trees cannot obtain a secure foothold, hence they are often overthrown by storms. Some of them seem to be but little inconvenienced by this. The sound roots continue to act as before while the prostrate trunk sends up new growth. The next storm may again overturn the whole affair and the process of growth is again readjusted. I have seen live oaks that have been overthrown four times, the trunks being split and twisted half way around, yet no apparent damage had resulted.

Polypodium polypodioides on Dead Trunk of Oak. This Fern Turns Brown and Shrivels up in Dry Weather but with a Quarter of an Inch of Rain it Opens its Fronds which Turn Green and Begin Growth

I have called the live oak our stateliest tree, the Achilles of the hammocks, and like that hero it has a vulnerable spot. When it has finished its pioneer work, and the floor of the forest has become a deep bed of leaf mold; when there is no longer danger that the center of the forest will be devastated by fire, a final immigration of strictly tropical trees arrives. These last arrivals cannot live in the fire zone and can only grow in rich soil and in the dampness and protection from cold afforded by the completed forest. Like most of the tropical emigrants they have lived for countless generations in the Torrid Zone; they and their ancestors have struggled for light, for food, and for a place to live in denser forests than these and where the battle for life never ceases a second in the year. They have become fighters from necessity; their forbears were warriors of cunning and strength, and they have inherited the instinct of aggressiveness.

The young trees of these later migrants can flourish in more crowded situations and where there is less light than can the natives of the warm temperate regions. The ground in a tropical forest is an almost solid mass of roots which are

fighting desperately for moisture and plant food. Those of the West Indian trees are better fitted for obtaining a share in such forests than are the oak roots, or those of the red bays, the persimmon, or prickly ash of our Southern States. It is for this that the latter invariably give way before the former—the trained soldiers of the tropics. One will find hundreds of seedlings and young trees of tropical species in the midst of old and established hammocks, but it is rare indeed to encounter a young live oak or sweet bay in like situation, but if he does he may be sure it is doomed to early death.

But the especial enemy of the live oak is our common strangler, *Ficus aurea*, an account of which is given in the chapter on the survival of the fittest. In any large hammock a number of these old patriarchs may be seen enfolded in the stifling embrace of this terrible Ficus. This, then, is the arrow that reaches the heel of our hammock Achilles. Whenever in the dim, crowded forest one of these monarch oaks dies of old age or strangulation no other comes to take its place. It is one of the injustices of nature that this noble tree which has fought the fire with matchless courage

and gone forward as a pioneer to establish the forest should at last be dispossessed by other trees whose very existence it has made possible.

The finished hammock forest consists almost entirely of tall, straight, closely set trees of tropical origin. They stand erect as soldiers on parade; their dense, leafy tops shut out nearly all the rays of the sun. For this reason but few epiphytes grow. This part of the forest is grand and gloomy; but it is not so picturesque or lively as is the younger stage.

These are "The Hammocks, Florida's one unique, priceless heritage," as Prof. W. H. Henry has beautifully expressed it. They should be cherished for their beauty and for the rare vegetation they contain. Once destroyed they can never be replaced quite as nature has made them, and Florida would be despoiled for all time of one of her most important attractions.

CHAPTER X

In the Primeval Forest

IN another chapter I have traced the development of the hammock from a single live oak beside a sink or swamp to the tall, solidly grown tropical forest. Prominent among such Florida forests is, or rather was, the great Miami hammock. Formerly it stretched for miles along the shore of Biscayne Bay, occupying most of the site of what is now the city, and extended half a mile inland. On account of the encroachment of this flourishing settlement much of it has been destroyed and only a remnant of its former beauty and stateliness remains.

It occupies what is probably the highest ground of any part of southeastern Florida and some of it was probably the first to be lifted above the sea after the great Pleistocene subsidence. It is quite certain that when the forest covering this site began to develop, the outer peninsula ending in

Views in Brickell Hammock, Miami, Illustrating Dense Tropical Growth in Primeval Forest. Lower View along Old Road

Both by Prof. F. G. Smith

Cape Florida did not exist, and the Upper Keys were only a low, coral reef; at any rate it was the shore line open to the sea over which seeds of tropical trees and plants were drifted to it. I have no doubt this is the oldest hammock in the lower part of the State, and long before the white man began his work of destruction it contained over a hundred species of trees and large shrubs. Here were, at least, two species of fine tropical trees which have never been found elsewhere within the limits of the United States, one a member of the laurel family (*Misantica triandra*) and one of the soap berries (*Talesia pedicillaris*).

Long ago a part of the hammock in the vicinity of the "Punch Bowl" (a curious depression in the rock near the shore) was cleared, planted, and afterwards abandoned. This cleared portion grew up with second growth which attained considerable size. Only a part of the original forest still stands and it is probable that most of that will soon be destroyed. Let us enter it now before it is too late to observe, study, and wonder; to be filled with reverence at sight of so magnificent a growth; for like an old Greek or Roman temple it is stately and beautiful, even as a ruin.

The border of the forest is almost everywhere a dense scrub, consisting of low-grown live oaks, red bay, cabbage palmetto, the common sumac (*Rhus obtusifolia*), prickly ash (Zanthoxylum), Trema, French mulberry (*Callicarpa americana*), wild coral tree (*Erythrina arborea*) and one or two species of lantanas. There are several vines in the border thicket, some unpleasantly thorny, and among them are species of smilax and of the unpleasant Pisonia, so it is very difficult to penetrate the inhospitable tangle.

The floor at the border of the forest is rocky and uneven, there being but little sand and leaf mold in the depressions. In this the trees get but a poor hold and when overturned by a storm they tear up the limestone much as do the trees in the pineland. As we go farther into the wood we find an increasing number of tropical trees and a decreasing proportion of the warm temperate forms; the growth becomes taller, straighter, and closer.

In the newer and more open part of the forest epiphytes are most abundant; with most favorable conditions they burden the trees almost to the breaking point. In South Florida there are

known to be about twenty-two species of native, epiphytal orchids, but most of them have little claim to beauty; a few only are really ornamental. One of these (*Cyrtopodium punctatum*) is so remarkable that it deserves especial notice. It grows on trees in the littoral, or in the high hammock, though it favors the former. The roots of most epiphytal orchids cling to the bark of the tree on which they grow, often following along the crevices in the bark and probably finding a little plant food in them. Those of the Cyrtopodium attach themselves to the bark and then suddenly turn upward and outward after the manner of the ex-Kaiser's mustache. Thus they form a sort of basket to catch every leaf, dead twig, insect, and whatever else may happen along. When these decay they fertilize the plant. Some of these orchids become very large, having dozens of stout, fusiform stems or pseudo bulbs, bearing broad, attractive leaves, and the "basket" may hold a bushel. The flower stems, bracts, and rather large blossoms are greenish yellow, blotched, and irregularly striped with brown. When the hundreds of blossoms open it is a splendid sight. Several other species of orchids perch on the trees

along with a great variety of Tillandsias or air pines—"poor relations of the pineapple" as Bradford Torrey aptly called them. The strange effect of so many air plants is often heightened by a drapery of Spanish moss which hangs in long, weird streamers. With these epiphytes is associated a Catopsis and along the horizontal or leaning stems of the live oaks is a lovely Peperomia, a closely clinging creeper with thick, obovate leaves and rat-tail spikes of greenish flowers. It is one of only four members of the pepper family growing in Lower Florida.

This part of the forest is a veritable fern garden. Along the trunks of the live oaks the exquisite resurrection fern (*Polypodium polypodioides*) with its delicately cut fronds forms solid mats, which awaken into growth and beauty with the coming of rain and turn brown and desolate when the weather is dry. Among the palmetto boots is the large serpent fern, so called because its knotted rootstocks resemble the twisted bodies of snakes. There are long tufts of grass ferns on the palm which sometimes droop five or six feet and are then striking objects. Here also is one of the most attractive plants in the forest (*Campyloneurum*

**Densely Crowded, Straight Trees in Brickell Hammock, Miami.
Note White Smooth Trunks**

Photo by Prof. F. G. Smith

phylliditis) with long, graceful fronds growing on decaying logs, and on the ground—the lovely sword ferns. There are many others too numerous for special mention.

We may enter a road cut long ago through the forest and follow it until it becomes a veritable tunnel, the top and sides of which are formed by the tall, closely set trees. We are now in the primeval forest and on either side of us is a solid wall of vegetation towering up sixty or seventy feet. The sight to me is always an inspiring one and it fills me with a vague sense of fear. The trees are not so large as some of northern forests, but they are tall, straight, and huddled together, and are interwoven above in an inextricable tangle. Overhead the sky is almost wholly shut out by the dense canopy of foliage and though it is midday outside it is evening within, in places almost night. The character of this forest is very different from that of its own borders or from that of most hammocks of Lower Florida. This forest is quite open below, having but little undergrowth on account of the darkness, and there are almost no vines or sprawlers. Within a radius of fifty feet one may find as many species of trees and large

shrubs, and all are tropical. In fact there are as many different kinds of trees within an acre of this forest as grow wild in any state of the Union wholly north of the fortieth parallel of latitude.

As I have said there is only a limited amount of growth on the floor of the forest. No matter how perfectly a plant may be adapted to living in the shade it is necessary that it should have *some* light, and over much of this forest floor the sun never shines. The birds, the insects, the foliage, and blossoms—all life—are up in the tree tops in the glorious sunlight. Even butterflies are rarely seen, however common in more open places. A few large arboreal snails (Liguus) live on the tree trunks or shrubs, but even they are far more abundant in the more open sunlit parts of the jungle. That they are plentiful high up in the tree tops where they are exposed to the light is proven by the large number of dead shells, or "bones" as collectors call them, scattered over the floor of the hammock. As Kingsley has said of a similar forest in the Island of Trinidad: "You are in the empty nave of the cathedral and the service is being celebrated aloft in the blazing roof."

Immense "Gumbo Limbo" Tree (*Bursera gummifera*) in Cutler Hammock (Charles Deering Estate). It is Said to be One of the Trees Which Produces Gum Elemi of the Druggists and This Name may be a Corruption of the Native One

Photo by Wilson Popenoe

What are the trees which compose this forest? You cannot so easily tell because the foliage is far above your head and it is too dark to distinguish it. Occasionally a limb hangs down so that one can observe its leaves but barring this an expert botanist, familiar with all this growth cannot positively determine the trees by their trunks alone. From the road or a cleared spot you will likely see a very large tree, somewhat crooked and with smooth trunk of a rich coppery color; the leaves glossy. This is a gumbo limbo (*Bursera gummifera*), the most striking object in all the hammock. Even the dullest or most indifferent tourist looks at and asks what it is. Its outer bark peels off in thin paper layers like that of the birches, hence it is sometimes called "West Indian Birch." It belongs to a family rich in balsams and it is said to be one of the trees which furnishes the gum elemi of the druggists. Another tree, the satinleaf (*Chrysophyllum olivæforme*), with intense, metallic green, glossy leaves, the under surfaces of which are covered with brownish golden hairs, is thrust out into the open where we can readily observe it. These hairs are closely appressed and when the wind turns the leaves they

flash like golden satin, and glow with a sort of radiance or sheen.

There are the mastic and the poison tree, the latter a cousin of our northern poison ivy, there are—hog plum, pigeon plum, darling plum, and two species of coco "plums." The lovely paradise tree will be seen with its long, handsome pinnate leaves shining as though freshly varnished. Every part of it is intensely bitter and it is probably one of the trees that furnishes quassia chips. Here is the wild lime and its near relative the "toothache" tree, with bark and leaves acrid enough to cause or cure—anything. There is the locustberry, which may be either a shrub or a tree, bearing daintily beautiful blossoms, and the soapberry, the fruit of which when macerated in water produces a lather with all the qualities of soap. There are ironwood, lancewood, fiddlewood, inkwood, white-wood, yellow-wood, torchwood, and the beautifully variegated crabwood, used to make canes and various ornaments. The torchwood is so filled with resin that it is used for torches; it may also be a source of gum elemi, as its specific name *elemifera* would indicate. There are also dogwood, naked wood and, in the vicinity of the

shore, buttonwood. There are a half dozen different stopper trees, members of the myrtle family, and all handsome evergreens. In places the calabash tree is common with fruits as large as a small coconut but these cannot be used for household utensils as are the fruits of its West Indian relative. Occasionally one finds the strongback, so named, no doubt, on account of its hard durable wood; and now and then one sees the lovely glossy-leaved West Indian cherry and the equally handsome papaw.

I do not give the scientific names of most of these since they would add more of confusion and complication than of valuable information. Although there are several trees in the northern states which have the same common names as some of these, yet none of them is identical or even botanically related. Almost all of the trees I have enumerated have common names in the Bahamas and West Indies and the natives distinguish one from another with the skill and certainty of a trained botanist, and they also understand something of their medicinal and other qualities. A northern botanist unfamiliar with this tropic flora would be completely bewildered

and unable to refer a half dozen of the trees to their genera or families. What of the medicinal and useful properties of these many species of trees, what part do they play in the economy of the forest? Where and when did each one first land and become established on our shores—and whence; what changes have taken place among them since they first arrived? Science knows but little of them. The most ignorant Bahama Negro can tell more about them than can the ablest botanist. Verily the forest is full of unanswered questions!

I have said that the older part of this forest is wholly tropical but I must slightly modify this statement. Here in the very densest and oldest part of it is a northern tree, the common red mulberry (*Morus rubra*) which seems to be as much at home as any of the tropical immigrants. These Antillean trees, as I have explained, drive out all the temperate and warm temperate growth; why, then, this exception? This was long a puzzle to me and I am not so sure that I have yet solved it. The mulberry is a member of the Moraceæ, a family including the breadfruit and belonging mostly to the tropics; it has only a few outliers in temperate

Dense Tangle of Tropical Vines in Cutler Hammock, Estate of Charles Deering

Photo by Wilson Popenoe

regions. Now this particular tree is well adapted to living under a great variety of conditions, for even in this locality it grows in brackish and fresh-water swamps, in all kinds of hammock, and out into the borders of the pineland. The ancestors of this tree probably lived in the tropics and one of them migrated into colder regions and became inured to a more rigorous climate. Our mulberry possibly inherits all the courage and fighting instincts, if I may so express it, of its forbears and relatives of the Torrid Zone.

The distribution of this tree is very extensive and somewhat peculiar. It occurs from Texas to Eastern Nebraska, eastward through Michigan, Ontario, and Western Massachusetts, south to Cape Romano and Biscayne Bay, occupying almost the entire eastern part of the United States. It is not known from extreme Lower Florida or the keys. One may reasonably suppose that the line of its migration is from the highlands of Mexico through the southwestern states, into the far north and east and southward into the lower part of the Florida Peninsula. Is it another Prodigal Son who, after leaving the parental roof

and wandering far and wide, is seeking to return to the home of his father?

It will be noticed that most of the leaves of this forest are rather small, that they are entire (having no serrations or lobes), that they are of firm, thick texture and are usually glossy above. In all these particulars they differ decidedly from the leaves of the northern woods. In cooler regions of the Temperate Zone the trees have what might be called "hurry-up leaves." During half the year the weather is too cold for vegetable growth and as a consequence there is a complete rest among plants. The warm spring starts the sap to moving, but there is only a brief season for growth and the preparation for another winter. The proper kind of leaf for such conditions is thin, with roughened surfaces and irregular edges—one exposing the greatest possible amount of surface to the air and light. And it is just such leaves we see in the northern forests. Practically all the growth of northern deciduous trees is made in six weeks, and during this brief time the leaves are rushing the crude sap up from the roots and exposing it to the sun for the necessary process of elaboration, so that it may be returned in proper

condition to form the wood of the tree. There is no time to waste, for cold weather follows quickly and the wood must be hardened and the buds completed before winter.

In the tropics conditions are very different. The summer is the period of growth, as in the Temperate Zone, and during the balance of the year most of the vegetation is more or less dormant, also as in the temperate regions. But there is no cold weather in the tropics and a large proportion of the trees retain their leaves throughout the year; in other words, they have persistent foliage. The leaves, then, must do duty for several years and they must be made to last and stand hard service. Having to endure long dry seasons, they are usually rather small, their upper surfaces are smooth and glossy, their substance is thick and leathery, their edges are entire. In dry weather they close their pores, and probably add a little to the coat of varnish on the upper surfaces; then they practically cease all functions. They do finally grow old and wear out, falling most abundantly during the seasonal rains. One reason they are so hard and glossy is to resist the constant attacks of insects.

In Lower Florida a few of the temperate and warm temperate trees shed their leaves in the fall, and in the late winter or early spring put on new ones. The willows often leave out and bloom in January and the mulberry dons its bright green new garments a little later. The live oaks and bay trees awake in February, casting off the old, as they acquire the new leaves. The gumbo limbo and poison tree may lose their leaves through the winter, and if the weather is cold the dogwood does also. However, most of the tropical trees pay no heed to the increasing heat of spring; they merely stand and soak in the sunshine and warmth but make no attempt to grow. In Lower Florida the rains usually begin the latter part of May or early in June and at once the tropical forest awakens to great activity. The leaves of most of its trees suddenly become dingy and fall—they seem to be pushed off by the rapidly growing new ones. Soon the change of clothes is made and the forest is splendid in its fresh mantle of rich young foliage, of many shades of reddish brown or vivid green. The floor of the hammock is thick with dead leaves which rustle under foot as in a northern November. On the ground autumn has taken

full possession, while aloft in the tree tops spring has begun her joyous reign. In the late winter there may be another revival—a sort of secondary spring and autumn combination, especially if the weather changes from cold to continued warmth and rain is abundant.

In the tropics the new foliage is often renewed with remarkable suddenness. I remember during a winter spent in Spanish Honduras some fine large Ficus trees which I greatly admired on account of their glossy, dark green leaves. One morning I noticed they were turning yellow, by the next day brown, and I became alarmed, thinking the trees were dying. The third day nearly all the leaves had fallen while pale new ones were appearing. A week later the trees were newly clothed with full-grown foliage. For years I could not understand the reason for this strange performance but finally in Rodway's *In the Guiana Forest* I read the explanation of the mystery.

The air in dense tropical forests is always more or less moist and growth may take place at any favorable opportunity. In the fearful struggle for light, space, and food, if an opening be made by the falling of a tree, the other trees round

about immediately send new branches into it and in no time the space is filled with fresh growth. It is evident that if any tree remained bare of foliage for long its neighbors would steal its hard-earned place in the blessed light and it would perish. Although the forest around these particular Ficus in Honduras had been cut away, and no necessity existed for a hurry change of clothes, yet these trees from force of habit did what their ancestors had done for countless generations. They took no chances.

The Lower Florida winter climate is colder than in the tropics and little tree growth is made during the cool, dry part of the year. Consequently haste is not so necessary in renewal of leaves. Thus the mulberry remains leafless from fall until spring. But the Ficus and some others retain the instinct of their forefathers and remain bare but a short time.

The air roots of *Ficus aurea* (and sometimes their branches) become fused together when they long remain pressed in contact. Cases of natural inarching, that is, uniting together two branches in a longitudinal union, are very unusual. In my own hammock a pigeon plum (*Coccolobis floridana*)

has furnished an interesting example and I puzzled a good deal over it. I could understand how two limbs growing side by side and becoming chafed might start to unite their abraided surfaces, but in a windy region how could they be held together for the several months necessary to complete the process? The slightest move of either branch would break the incipient union. One day there came to my hammock a man who had spent many years in the tropics and is a born naturalist. Examining the queer inarch he said: "I think I know. After the bark of these limbs was abraided a twining vine grew around them, binding the two parts so firmly together they couldn't move, and since the union the vine has died." Then I wondered at my own stupidity.

A striking feature of these great forests is the vines—"lianes," "sipos," or "bushropes" as they are variously called in the tropics. In places they reach the upper limits of the tree tops and project down again. Sometimes they are drawn taut and again they hang in loops or festoons, or they coil about in dense masses, and crawl over the ground like endless serpents. Usually the visible parts of the stems are wholly naked, for they are mere water

pipes which carry sap to the foliage up out of sight on the roof of the forest. One wonders how they have managed to climb to the tree tops, as they are usually swung entirely clear of any support in their lower parts. These hanging lianes simply rest on the limbs fifty or sixty feet above the floor of the forest. A few of them are sprawlers, as the pull- and haul-back (*Pisonia aculeata*), and these crawl and slide upward as they grow over shrubbery and the lower branches of trees. The method is different with the ordinary climbers which ascend by attaching themselves to anything by means of their tendrils. On some of the Florida Keys and at Paradise Key in the Everglades a Hippocratea (*H. volubilis*) is very abundant. This giant tropical vine sends out a pair of tendrils at each joint which tightly clasp any other vine or tree up which it proceeds to climb. Often the union of the support and supported is so close that the two stems seem as one and it needs careful inspection to distinguish them apart. Each tendril bears three leaves at its extremity and after the vine has reached the top of the tree both tendrils and leaves drop off, allowing the stem to swing free. We have a Cissus and two other

grapes which sometimes form bushropes, and also our common northern woodbine, which climbs by adventive roots. There are also several others.

When these have reached the light and air of the forest canopy they are no longer concerned about their means of ascent. Their upper parts once secure among the topmost branches, the tendrils, no longer needed, decay and the unfastened stems hang in all manner of picturesque and fantastic attitudes. The young aspiring vines need less light than most vegetation.

The building of a ship, of a house, or of any other monument of man is invariably accompanied by incessant noise. In this busy workshop of the forest amid the most intense creative activity there is an oppressive silence and no visible motion. Nature's machinery operates so smoothly the entire forest might as well be dead for all that one may see or hear of the work going on.

Unless especially gifted in a sense of direction one is in danger of getting lost in these jungles for it is very difficult to locate the sun, however brightly it may be shining without. Notwithstanding the great variety of vegetation, the forest is after all very monotonous and, to an

unpracticed eye, every part looks exactly alike. Even with a compass I find it necessary to be watchful whenever I venture alone into the great forests; one constantly encounters the obstructions of fallen timber or tangled vines to prevent a straight course.

How old are the primeval forests of Lower Florida? It is impossible to guess even within centuries. At the farthest limit none can possibly be older than the latter part of the Pleistocene, and, geologically speaking of course, that epoch only began yesterday; it marked the falling of the curtain upon the great drama of the physical world's past history. Since the close of the Pleistocene, conditions on the earth have been essentially as they are now and geologists call this brief period "the Recent." It is, then, within this last flicker of cosmic time these hammocks began to develop. When we talk of age in terms of the calendar we speak another language and we must also employ quite different standards of comparison.

The new outer parts of the forest are less than a century old; some of it is much less. The live oaks, those patriarchs of the forest, date much

farther back—some of them doubtless are several hundred years old. The exclusively tropical parts of the forests are very much older. It has required much time for sufficient leaf mold to accumulate to prepare the way for these fastidious warriors. This could only begin after the hammock was dense enough to repel the fires that for ages crippled them. This mold is sometimes two or more feet deep. The age, then, of this finished forest must be reckoned not by centuries but by milleniums.

But an enemy has arrived, against which the hammocks have no defense, and this is civilized man. The farmer tempted by their rich soil has attacked them with fire and axe in order to build his home and raise fruit and vegetables. It has required of nature centuries to perfect a hammock which man completely destroys in a few weeks.

The human is a greedy creature of abundant and costly needs and he destroys, often wantonly, that which nature has so generously provided. The shells of the fresh-water mussel are now used for the manufacture of buttons, and he dredges millions of specimens too small to use and merely dumps them on the shore to die. He fills the

streams with the poisonous sewage of his cities; he drains the earth of its oil and gas and lets the one run to waste and the other to burn as it escapes. He exhausts the soil and then abandons it; he is a destroyer and not a conserver.

CHAPTER XI

Along the Stream

ALL the streams of Lower Florida are mere drains of the Everglades and the rather narrow region of cypress swamps. I doubt if any of them are over fifteen miles long and like everything else in this area they had their birth only yesterday.

The southwestern shore of the State is less elevated than the southeastern and the slope of two thirds of the lower part of Florida is toward the Gulf of Mexico. When Willoughby crossed the Everglades he entered them from Harney River and at his Camp Number 6, about due west of Miami and twenty miles from the east coast, he found the water of the Glades still moving to the southwest. The streams which enter the Gulf of Mexico within our region have no real valleys and even on the east coast, where they break through the great rocky ridge, their depressions are feebly

marked. The upper parts of the streams are ill defined in the great swamp. Their lowest parts are mere lagoons, ramifying among the mangroves.

It has been asserted that within the lifetime of our plants and animals the peninsula of Florida was elevated until a land connection was established with the Island of Cuba and that over this land way much of our tropical life has migrated. To form such a passageway it would have been necessary to elevate the whole area three fourths of a mile, and had the land remained at this level long enough for any considerable migration our streams would have eroded deep valleys in the soft rock. The surface of the peninsula would have been worn into a very irregular topography and the valleys once occupied by the streams would now be fiordlike inlets of great depth. As a matter of fact the beds of our streams are composed of Pleistocene deposits, and none of them has ever been lowered below their present level. An additional proof that Cuba and Florida have never been connected since the present flora and fauna have existed lies in the fact that Cuba with a thousand species of land snails possesses one of the richest mollusk faunas on earth. Had a land

Upper View. Mouth of Little River

Lower View. Same Stream a Short Distance above Mouth

Photo by Everett A. P. Marguett

bridge existed it is certain that with the advent of tropical plants a large number of Cuban snails would have migrated to our region. As it is one can almost count on his fingers all such species living within our territory or which by any possibility could have been derived from them. This is exactly the condition we would expect to find if life from Cuba had been brought to Florida by ocean currents.

Florida is so lacking in any striking natural features that the few it possesses receive exaggerated names, and so it happens these short water courses have been called "rivers." They are all divided into two quite distinct parts—first an upper, fresh-water stretch reduced to a rivulet or a dry bed in winter or becoming a powerful stream in the rainy season; and second, a lower, estuarine part of generally brackish water in which the tide ebbs and flows. A few of them on the east coast flow between low limestone walls, having doubtless begun their existence as water passages under the rock. Cutler and Snapper creeks were examples of this before their channels were artificially opened, and Arch Creek still passes under a natural bridge.

On the east coast the rocky rim of the Everglades is slightly elevated and there are rapids where the streams break through. In the estuarine parts there is often a depth of six to ten feet caused by the scouring action of the tides and the solution of the rock—all aided by a recent slight subsidence of the land. On the southeast part of the State there are, from north to south, New River, Snake, and Arch creeks, Little and Miami rivers, Snapper, Cutler, and Black creeks and Chis Cut. On the south are Taylor River and an unnamed stream which drains Cuthbert Lake. The streams of the lower west coast are, from south to north, Big Sable Creek, Jos, Shark, Harney, Fatsallehonetha, Rogers, Chittahatchee, Fatlathatchee, Alcatapacpachee, and Lakpahatchee rivers, Weikiva Inlet, Chokoloskee, and Corkscrew rivers, with several fortunately unnamed outlets. Some of the above have names sufficiently long and complicated for streams a thousand miles in length; obviously they are Seminole, and they have abundant time to pronounce them.

There is often a residue of grayish or slate colored marl deposited in and around the border of the Everglades, and some of this is carried down

by the streams during high water to form extensive mud flats at their mouths. Muck and peat may be added by the rank vegetation which springs up on it. A bar frequently forms just outside the debouchure. I believe these bars are formed in quite the same way that are the parallel islands and peninsulas along the coasts—that is, by two opposing currents.

A trip up any of these streams reveals much of beauty and interest. Having crossed the outer bar, where the water may be so shallow that it is difficult to pass with a skiff, one at once finds a depth of from six to ten feet, and this depth may be carried for a long distance up the estuary. Generally the bottom is of solid limestone, with an occasional mud bar. The lower course of the stream is likely tortuous and bordered with a dense growth of mangroves and other littoral trees. These are often large and tall, their tops completely arching the estuary. The low shores are a tangle of roots, and the mud is thickly studded with the quill-like pneumatophores of the white and black mangrove. In this complex will be found two species of giant Acrostichums, half aquatic ferns which are equally at home in brack-

ish or fresh-water mud. One of these reaches a height of twelve feet and the growth is very dense. Two lusty vines or sprawlers (*Ecastophyllum brownii* and *Rhabdadenia biflora*) entwine the shrubs and trees, sometimes attaining the forest roof; both bear attractive white flowers. A handsome broad-leaved tree (*Crescentia cucurbitana*), one of the tropical calabashes, is abundant and carries its curious purple blossoms and large oval fruits at one and the same time. Here and there the mud slopes smoothly down to the water, free from any kind of growth, and very rarely one sees a swift movement and hears a commotion as an alligator rushes down this "crawl" into the water. Still more rarely something which resembles a long, straight saw palmetto stem is seen floating but approached it disappears with a swirl and splash, for a second revealing a crocodile (*Crocodilus acutus*). This saurian is found in the United States from the upper end of Biscayne Bay to Cape Sable and inhabits a large part of tropical America. It has been maintained to be of very recent record in Florida, but Stejneger has called attention to Rafinesque's publication concerning it in the *Kentucky Gazette* of 1822. This strange,

half-demented naturalist had a remarkable faculty for finding rare and unknown animals.

The crocodile may be distinguished from the much more common alligator by its narrow snout, by its greater activity, and by the character of its nest. It simply scoops out a hole in the sand and deposits fifty to seventy-five eggs in successive layers, smoothing over the cache in a perfectly level manner. The alligator lays its eggs well back from the fresh-water streams, the nest being hidden in vegetation and finally finished with a mound of leaves, dead wood, or stumps. In their battles the clumsy alligator is no match for the crocodile with its powerful array of long, sharp teeth. For much information concerning these giant reptiles I am indebted to Willoughby who tells (in *Across the Everglades*) of killing a thirteen-foot specimen, and also to Dimock's accounts of them in his *Florida Enchantments*. He captured one on the south shore of the mainland fourteen feet and two inches long. Dimock also gives very interesting accounts of alligators.

I doubt if the latter reptile has ever been so abundant or aggressive in Lower Florida as it was formerly in the northern part of the State. I

have never heard of it voluntarily attacking a full-grown person in our region, though tales are told of its catching and eating children. Bartram tells some astonishing stories of the vast numbers, great size, and ferocity of this reptile on the St. John's River. He states that he was repeatedly attacked by alligators and obliged to fight for his life; that they actually endeavored to upset his boat. In a narrow place in the river, he relates, the water was filled almost solid with various kinds of fish, and to prey upon these the alligators assembled in countless numbers. He goes on to say that the latter were so close together that it would have been possible to walk across the stream from shore to shore on their heads. His description of these animals as he saw them on the St. John's is so perfect that I cannot resist the temptation to give it literally. On page 125 of his Travels:—"The alligator when full grown is a very large and terrible creature, and of prodigious strength, activity, and swiftness in the water. I have seen them twenty feet in length, and some are supposed to be twenty-two or twenty-three feet. Their body is as large as that of a horse; their shape exactly resembles that of a lizard, except their tail, which

is flat or cuneiform, being compressed on each side, and gradually diminishing from the abdomen to the extremity, which, with the whole body, is covered with horny plates or squammæ, impenetrable when on the body of the live animal, even to a rifle ball, except about their head and just behind their forelegs or arms, where, it is said, they are only vulnerable. The head of a full-grown one is about three feet, and the mouth opens about the same length; their eyes are small in proportion and seem sunk deep in the head by means of the prominency of the brows; the nostrils are large, inflated, and prominent on top, so that the head resembles, at a distance, a great chunk of wood floating about. Only the upper jaw moves, which they raise almost perpendicular, so as to form a right angle with the lower one. In the fore part of the upper jaw, on each side, just under the nostrils, are two very large, thick, strong teeth or tusks, not very sharp, but rather the shape of a cone; these are as white as the finest polished ivory, and are not covered by any skin or lips, and always in sight, which gives the creature a frightful appearance: in the lower jaw are holes opposite to these teeth, to receive them: when they clap

their jaws together it causes a surprising noise, like that which is made by forcing a heavy plank with violence upon the ground, and may be heard at a great distance.

"But what is yet more surprising to a stranger is the incredibly loud and terrifying roar which they are capable of making, especially in the spring season, their mating time. It most resembles very heavy, distant thunder, not only shaking the air and water, but causing the earth to tremble; and when hundreds and thousands are roaring at the same time, you can scarcely be persuaded but that the whole globe is violently and dangerously agitated.

"An old champion, who is perhaps absolute sovereign of a little lake or lagoon (where fifty less than himself are obliged to content themselves with swelling and roaring in little coves round about) darts forth from the reedy coverts all at once, on the surface of the waters, in a right line; at first seemingly as rapid as lightning, but gradually more slowly until he arrives at the center of the lake, when he stops. He now swells himself by drawing in wind and water through his mouth, which causes a loud, sonorous rattling in the throat

for near a minute, but it is immediately forced out again through his mouth and nostrils with a loud noise, brandishing his tail in air, and the vapor ascending from his nostrils like smoke. At other times, when swollen to an extent ready to burst, his head and tail lifted up, he spins or twirls round on the surface of the water."

I know of nothing more fascinating than some of these lower stream reaches, and the effect as one drifts silently along them by moonlight is indescribable. It is all so uncanny it seems more like some scene of middle geological age than of the present, and I never visit one of these estuaries without half expecting to see Plesiosauri crawling about on the mud or Pterodactyls hanging from the branches.

There is generally a stretch of brackish prairie just inside the outer screen of mangrove and this is more or less covered by saw grass. The banks of the stream here may be bordered with cattails (*Typha angustifolia*) and the *Jussiœa peruviana*, the latter ranging from Peru northward throughout the Florida peninsula. It grows along the muddy banks of the estuaries and bears handsome yellow flowers, sometimes rooting in the muck or

half floating on the water. It sends up from its stems roots which resemble ordinary ones, but their office is strictly to aerate the plant for in reality they are simply oxygen pumps. The beautiful *Crinum americanum* with its large, starry, pure white flowers is often common along the banks and one or more of the elegant spider lilies (*Hymenocallis*) are seen peeping out of the saw grass. Farther up the estuary where the ground rises a little Myrica or wax myrtle, Annona or pond apple, coco plums (Chrysobalanus), and the swamp magnolia begin to appear.

At the end of the brackish water where the rapids commence, a small mollusk is sometimes found in great numbers on the rocks. This is one of the Neritinas (*N. reclivata*). Its nearly globular shell is dark green with narrow, longitudinal black stripes, and the accomplished animal can live in fresh or brackish water or even in the air. It is probably in process of becoming an air-breather altogether. Two members of the same genus live in the open sea along our coasts; this has gone landward to the intersection of fresh and brackish water, while several species in other regions live in water that is wholly fresh, and at

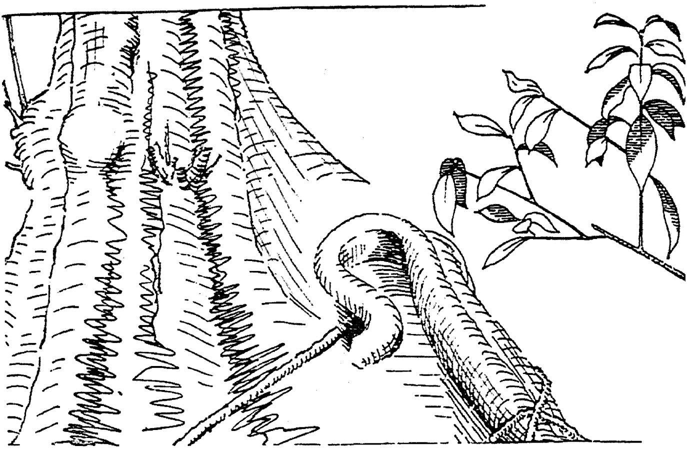
some distance from the sea. In the Philippines are some species of this genus (Neritodryas, from Nereis, a sea nymph, and Dryas, a tree nymph) *which live on trees at a distance of a quarter of a mile from the ocean!* The genus was probably derived from Nerita, a very similar group that is wholly marine.

Farther upstream where the water is entirely fresh one finds a variety of small mollusks in the sandy muddy bottom; several species of Planorbis, with their flat, closely coiled shells, so that there is a depression at both the spire and base. There is a related snail living in the upper reaches of the streams the shell of which resembles Planorbis and is likely an aberrant member of that genus. It has been called by several generic names but is generally known as *Ameria scalaris*. In some cases the shell is disk-shaped like Planorbis, in others it looks as though the spire had been awkwardly pushed up when in a plastic state; there is every variation between extreme forms. They grow by millions in the Everglades and scarcely any two are exactly alike.

Still another interesting fresh-water mollusk is found in the streams of Lower Florida. It is an

Ampullaria or "apple snail," called "idol snail" by the Indians of South America who hold it in reverence. All the many species of Ampullaria inhabit the warmer parts of the earth, and usually have large, globular shells. The animal is provided with a gill for use in breathing under water. In addition it has a pair of "siphons," the left one developed into a long tube so when lying on the bottom in shallow water it can extend it to the surface and breathe air. Here is a case in which the breathing operations go on perfectly whether the animal is on duty above or having the watch below. When the river goes dry they burrow deep in the mud and enter a state of æstivation, during which their various organs practically cease to function. It is said that some of the species may be taken from the mud during this sleep and kept for years in the air without injury.

Where the streams of the southeast coast flow through rocky hammocks they are very attractive. Some of them flow for quite a distance beneath the rock to appear farther down as great springs, and after a short visible course may disappear again. Along their hammock borders there may be sinks and small caverns which are sure to be



Upper View. Curious Root Growth of Annona which Serves as an Oxygen Pump for the Tree

Drawn by Forrest Clark

Lower View. Stream Reach with Brackish Prairie along its Banks

Photo by Pliny Simpson

veritable fern gardens. The exceedingly dainty spleenwort (*Asplenium dentatum*) often covers the damp rocks and walls of the grottoes and in places its delicate fronds are so crowded that they completely hide the surface of the rock on which they grow. They form a most elaborate and dainty tapestry.

Along the upper reaches we find more prairie but the vegetation differs from that of the brackish glades farther down. A few plants only are identical and among these is the saw grass (*Cladium effusum*) and a tall, striking reed (*Phragmites communis*) which is found in Bermuda, Europe, and throughout the eastern United States. It bears large, handsome panicles of purplish flowers which have a satiny sheen, and broad, glaucous leaves. Sometimes one may see the smaller mink (probably *Putorius nigrescens*) scurrying across an open space or slipping gracefully into the water. A pair of them lived in the lowland in front of my house and they appeared to subsist chiefly on land crabs. These they catch and after biting off most of their claws and legs they play with them, tossing them in the air and catching them as a cat does a mouse. More rarely a coon is

seen, for it is largely nocturnal; it also preys on land crabs. Often in the morning I have found the fresh carapaces of the latter lying along my lowland walk, with the soft parts completely cleaned out by these animals. The land crabs are found as far back as the Everglades.

There are a number of interesting aquatic plants in the freshwater reaches of the streams. In places the water purslane (*Isnardia repens*) fills the channel until it forms a dam. It has thick, bronzy, green leaves, and is a member of the evening primrose family. Here too is the pretty water pennywort (*Hydrocotyle umbellata*) with round leaves elevated a little above the mud, and the Proserpinacas with floating stems and several kinds of leaves. In such places one may find a lovely, low-growing, half-creeping plant (*Monniera*) with bright green, succulent leaves and pretty purple flowers forming a sod, and often with it the dainty Samolus or water pimpernel with small but attractive flowers. Here I have found, either floating or stranded in the mud, one of the strangest plants in the world. It is a Lemna or duckweed (*L. minor* probably) which has a wide distribution in North America,

Along the Stream. Cutler Creek at Junction of Fresh and Brackish Water. Giant Ferns (*Acrostichum*) at Left and Center

Photo by Wilson Popenoe

Europe, and the tropics of both Old and New worlds; it is the smallest flowering plant known! A disk less than a tenth of an inch in diameter floats on the surface of the water,—not a leaf, as we might suppose, *but the entire plant*, with the tiny rootlet which hangs below it. From the edge or the upper side of this little oval, light green disk, flowers, consisting of a stamen and pistil surrounded by a tiny spathe, appear from a fissure. It is generally propagated, however, by a sort of bud which springs from a cleft in the edge or base of the body, and usually four or five plants of various sizes may be seen attached to each other. It is, then, not only the smallest flowering plant but the simplest. It is a distant relation of the skunk cabbage and Indian turnip of the Northern States.

Sometimes the stream flows through a cypress swamp and in it will be found much of interest. Such spots are a bit uncanny by reason of the long moss which hangs from the trees and imparts a somber funereal appearance to the scene. The small, delicate cypress leaves are arranged in two series along the young deciduous stems and look as though they were pinnate. The great trunks have conical, fluted, or buttressed bases, and in

large specimens may be eighteen feet or more in diameter at the ground. Here it does not attain to the height or dimensions it does farther north, but it becomes one of our largest trees. Scattered through the swamp are erect, conical, woody growths known as "cypress knees," sometimes as tall as a man or even more, with neither branches nor leaves. To one who has never seen them before they are certainly most incomprehensible. Covered with bark and often fluted or buttressed, the growth of the wood usually goes up one side of the knee and turning at the top passes down the other, the whole being occasionally hollow. For a long time scientists were unable to account for these strange growths, but it is now generally conceded that they are pneumatophores or aerating organs which furnish oxygen for the trees, and the hollow, fluted bases of the trunks probably function in the same way.

As one proceeds through the swampy ground along the stream he will notice in many places that the mud of the banks is covered with tree roots of various kinds. They not only come to the surface but often project up and they roll over and clasp each other in a most fantastic

Along the Stream. Cutler Creek. Sink with Lovely Small Fern Covering the Rocks (*Asplenium dentatum*)

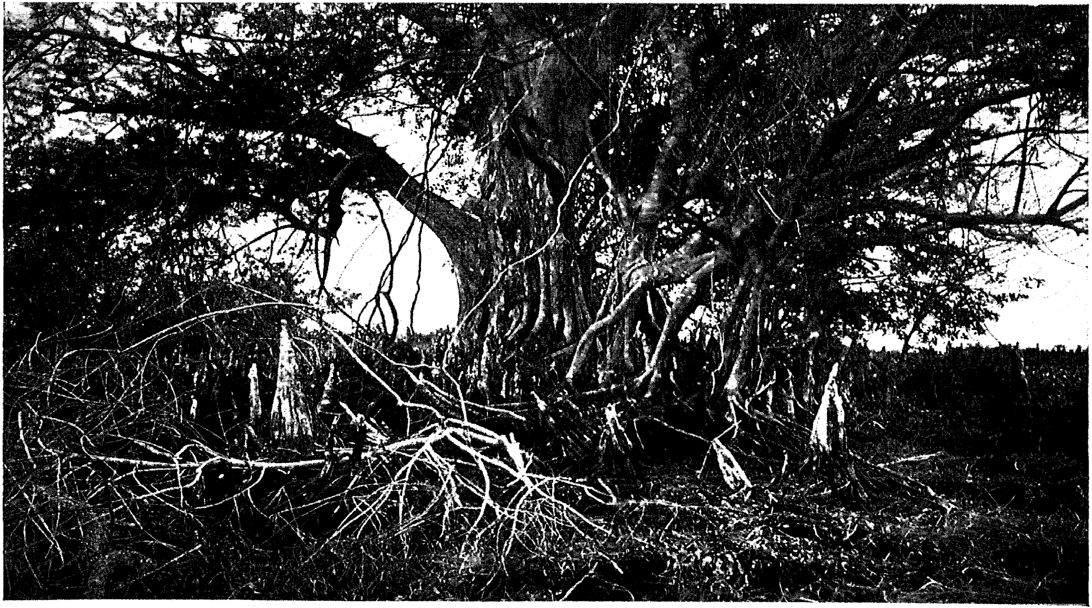
Photo by Wilson Popenoe

tangle unpleasantly suggesting a lot of interwoven serpents. Roots of the swamp bay run straight over the mud while those of the magnolia, cassine, bayberry, and some others twist and squirm into a bewildering complex. Here and there irregularly rounded knobs are thrust up and others are distorted into loops. The roots of the Annonas often rise well above the general surface of the swamp and form the most curious growths imaginable. They are sometimes locked in close embrace and roll over and over as if engaged in a death struggle, or again they may be turned into fantastic coils and volutes which look like a lot of senseless wood carving. *Ficus aurea* often grows on the higher parts of the banks, though it does not reach a great size in such unfavorable situations. The trees usually stand elevated on their roots in quite the same way as the mangroves, and when young they have such a dainty appearance that they impress one with the idea that they are afraid of wetting their feet.

Why should all these diversified roots seek the surface and even project up into the air? They certainly appear crowded and forced upward for room. I at first thought this to be the case.

There is often a depth of several feet of muck and peat below and if one investigates he will find that very few roots occupy it. So, then, there is no lack of space beneath the surface and the "crowded out" theory fails. Without a doubt they come to the top of the mud "voluntarily" and into the air to *absorb oxygen,* as the soil of swamps is almost destitute of that prime necessity. Often these roots are sent up to a height of several inches and then folded back so that the returning growth is in contact with the ascending, thus forming a perfect loop. These loops seem to explain the growth of the curious cypress knees which in ancestral forms doubtless grew in the same way but have now been further modified by consolidation into one united growth.

It seems to me that there is a soul throughout nature, that the animals, and I like to believe, the plants, to a certain extent, think, something in the same manner that human beings do. Howe invents the sewing machine, Bell the telephone, McCormick the reaper—all devices to perform some service for the benefit of man. A palm sends its growing stem deep into the earth and buries its vitals to protect them from fire; the mangrove



Large Tree of River Cypress Entangled with Strangling Fig. Note the Curious Cypress Knees Growing Out of the Swamp. These Doubtless Serve as Pneumatophores

Photo by Dr. John K. Small

raises itself high on stilted roots in order that it may live above the water and breathe; an orchid perfects a complicated device to compel honey-loving insects to cross-fertilize its pollen. Animals resort to all manner of tricks to conceal themselves from their enemies. All these work not merely for themselves but for the benefit of the race to which they belong. If the work of man is the result of thought that of animals and plants must be so in some lesser degree. If man developed from a lower animal, the superior from the inferior, where may we draw the line between reason and instinct?

Gradually as we ascend the stream it finally loses its character and becomes a mere, ill-defined, shallow drain for the swamp from which it flows. The Everglades lie just before us stretching away in monotonous grandeur; saw grass and other low vegetation cover the soft mud; the channel is finally lost in a network of slight depressions and the stream becomes merged into the mighty prairie.

CHAPTER XII

Along the Mangrove Shore

MANGROVES flourish along tropical and semi-tropical seashores the world around, though they are not found in Hawaii and a few other localities. They usually grow on the borders of brackish bays, lagoons, and lower stretches of streams but are sometimes met with on open and even rocky beaches. While there are several species in the Old World, only one, the common red mangrove (*Rhizophora mangle*), is found in the Western Hemisphere, and this has a fine development in southern Florida. It has been reported as ranging north to Cedar Keys on the west coast of our State and to Mosquito Inlet on the eastern side of the peninsula. It is a tender tree and in time of severe frost has repeatedly been killed outright in its northern range; hence the different records regarding its distribution in the State do not agree. During the

The Big Mangroves South of Little River. Tree in Center 27 Inches in Diameter and 75 Feet High. The Large Air Roots Spring from a Height of 20 Feet

Photo by T. E. Clements

heavy frost of 1886 it was totally destroyed near its northern limit on the west coast, and many trees were badly injured as far south as Cape Sable. I visited this coast in 1892, sailing along it from Terraceia Island in Tampa Bay to the lower end of Sarasota Bay, a distance of more than twenty-five miles, and everywhere the mangroves were dead and decaying,—a most melancholy sight. Here and there at long intervals the club-shaped seedlings had drifted in from more favored regions and were becoming established, these being the only living mangroves I saw.

Ordinarily the American mangrove is a large shrub or perhaps a small low-headed tree standing on arched roots, and is often without any regular trunk. In certain areas, notably the great swamp east of Florida city, it is only a low shrub which rarely reaches a height of three feet; except in size it has the usual habit. Among the Ten Thousand Islands, in places along the south coast of the mainland, and about the shores of upper Biscayne Bay, it becomes a tall and imposing tree. In the islands the trunks are closely huddled together; they seldom attain a foot in diameter and have but few brace roots, or even none at all.

Along the west shore of the northern part of Biscayne Bay these trees reach their greatest dimensions, individuals sometimes attaining a diameter of four feet and a height of a hundred. As a rule these great trees stand at some distance apart but their immense crowns intermingle. Formerly a magnificent forest, chiefly mangroves, stood just below the mouth of Little River and in it grew a number of the largest sized and finest specimens. Some of these were braced by air roots fully eighteen inches in diameter that sprung from a height of twenty-five feet above the ground, and in other cases slender roots dropped from the branches fully thirty-five feet above the soil. The trunks were straight and smooth, usually without branches below their stately crowns sixty to seventy feet above. These trees easily ranked among the most wonderful vegetable growths of the State of Florida. They were sacrificed to human avarice for the tannin in their bark and the potential furniture in their close-grained, red wood. To-day the whole forest is a desolate ruin.

Although attempts are made to explain the great diversity in the growth of the mangrove none are convincing.

Maze of Mangrove Growth, Lemon City, Florida

Photographed by Burton Holmes

A mangrove forest advances into shoal water by means of its arching roots and the young plants which spring up in very shallow places. The roots do not merely drop into the mud and take hold but they often continue to grow on, arching over and over, and extending for thirty or forty feet. Others drop from the branches twenty feet above and make fast in the mud. Occasionally a horizontal limb drops a root which fastens in the mud, after which the original tree dies and the new root becomes a tree, or the new may eventually become separated from the parent and both live independently.

In the economy of the tree the roots have a fourfold function. First,—they render the ordinary service of bringing up crude sap like all conventional roots. Second,—they act as pneumatophores or oxygen gatherers and pumps. The soil in swamps, as I have elsewhere said is lacking in oxygen, and trees living in them must resort to special devices to obtain it. The mangroves do this by exposing a great mass of roots to the atmosphere. Third,— they elevate the body of the tree well above standing water, for if the bases of these semi-aquatic trees were constantly submerged it

would kill them. Fourth,—they form the most wonderful system for bracing and holding the trees against storms and the fury of the sea. It is rare indeed that mangroves are injured by the assaults of the most violent hurricanes.

Besides these important offices for the tree, these roots greatly assist in building up and extending the land. They usually grow in soft mud, which they so completely fill as to render very firm. When a tree dies its roots do not decay below the surface of the mud but form a peat in which their forms are distinctly retained. I have often seen the sea encroaching on the shore and exposing old peat which was almost as hard as some rock. Nothing could possibly be devised better than these tangled roots for catching and retaining the flotsam and jetsam of the sea. I never look at these veritable traps, filled with every conceivable kind of trash, without thinking of the ballad of *The Spider and the Fly* in which the latter says in answer to the invitation of the former: "He who goes up your winding stair shall ne'er come down again." Whatever is carried in among these roots stays.

The growing roots vary from a quarter of an

Mangroves Arching across the Estuarine Part of a Stream, Dade Co.

inch to an inch in diameter and are very tender about the growing points where they may be snapped off like a young shoot of asparagus. Each rounded point is protected by a closely fitting, horny, brown cap, and if, before it reaches the mud, this should become loosened or torn off the root will not grow. As the swinging roots often strike each other or may be abraded in various ways they are not infrequently injured. Then, as a general thing, several roots branch out above the injured and dead point, all of which may persist until they reach the mud and become attached. By this means the tree gets even a firmer hold than if nothing had happened and turns misfortune into a positive advantage.

In order to extend its area the mangrove resorts to strange expediencies. Really it seems endowed with intelligence and cunning, so completely does it adapt itself to its very peculiar environment and profit by every feature of it. Average normal seeds do not grow until in the ground some time, in fact botanists now hold that many do not even ripen on the plant already exhausted by strain of blossoming and seeding and that they are cast off while still immature. Hence it is that certain

seeds take so long to germinate. Those of some palms, for example, lie in the ground actually for years before they come up. But the tropics is a region of wonders and therefore of exceptions to ordinary rules. The seeds of mangroves *sprout while they hang on the tree*, sending out club-shaped roots about a foot long. These fall, often into the sea, and may drift many miles to new localities. The growing point at the heavier end of the "club" sends out roots rarely while floating; but when it strands on some shallow bank it at once becomes attached to the mud and begins its career as a new tree. I once took several of these sprouted seeds and inserted them into mud and seaweed just below high tide and in forty-eight hours they had begun to throw out roots. In a week nearly all of them had become well attached and established as little trees.

Possibly in some instances seedlings float for a year or even longer and still retain their vitality. More often they fall into the soft mud near the parent tree and again they seek to germinate and grow on rough bare rocks. When they drop into soft mud or water they maintain a vertical position, the growing end down. But if the young plants

Along the Mangrove Shore. View from Outside near Lemon City

Photo by Everett A. P. Marguett

fall on mud too firm to penetrate, they must lie prostrate and seemingly powerless,—but not so at all;—in a short time roots are emitted from its base. Those from the *upper* side of the "club" being strongest and directed away from it attach themselves to the mud and begin to pull the little baby tree into an upright position. At the same time the small trunk curves upward, and soon the whole stands as straight as a soldier.

Mangroves grow in a variety of situations; on land rarely touched by high tide and down to low-tide mark, but not below this,—at least in Florida. I have reason to believe that the large, old trees are more sensitive to excessive wet than are the younger, smaller ones. Along the shores of Biscayne Bay I have seen large trees at about the limit of low tide but always dead or unhealthy. I take this as an indication that the area which they occupy is subsiding and that it has gone down measurably within the lifetime of these old trees. When young they are fairly rapid growers but when old they add little to their girth each year, and it is difficult to estimate the age of the larger specimens. In the cooler parts of the earth the trees add a single annual layer of wood that is

distinctly marked off from the rest, but in the hotter regions trees make a growth whenever conditions are favorable, and the layers of wood are not necessarily annual and are often ill defined. It is probable that the mangrove, in wet situations, makes but a single growth in a year, but its layers of wood are not well indicated. However, after carefully studying sections of these large trees I have placed their minimum age at a hundred years. If I am right we have evidence of a subsidence within the last century that may be measured in inches.

A walk along one of our mangrove shores, if scrambling and falling among the roots may be so called, is extremely interesting. On a recent "stroll" I made note of the following flotsam caught among the roots: leaves in great quantity and variety, especially those of Thalassia (manatee grass) and Cymodoce (turtle grass), both erroneously called seaweed. The bulky masses of these contribute greatly towards the building up of the land: trunks and branches of trees, saw logs, pieces of wood, some from, or parts of, vessels: part of a chair, slabs from a sawmill, a number of coconuts and other large seeds, a part of a saddle,

bamboo stems, shingles, parts of vegetable crates, cigar stumps, a bit of hose, dead land crabs and fishes, the remains of a bird, a piece of rope, a few marine shells, onions, a royal palm and a coconut petiole, and many corks and bottles—alas! for a dry State too!

The mangroves must have some especial attraction for bottles judging from their abundance among their roots. Beer and wine bottles, whisky flasks of all shapes and sizes, bottles with wide or narrow necks, long bottles, squat bottles,—their number is legion. An innocent stranger would naturally conclude that the inhabitants of this region must be a set of besotted drunkards, but the bottle crop must be laid instead to the passing steamers.

Associated with the mangroves on the firmer land is another littoral tree (Laguncularia) commonly called "white mangrove." Along Biscayne Bay it sometimes attains a height of sixty feet, but is oftener a large shrub. While not so aggressive a pioneer as the mangrove it is nevertheless an active land builder. It has a device of its own for catching trash and for aeration that is very effective. If one will examine the mud under one of

these trees he will find many curious, slender stubs or quill-like growths sometimes a foot in height, projecting above it and attached to the underground roots of the tree. These not only provide the tree with oxygen but they bind the mud together and hold all the finer trash which passes through the wider meshes of the mangrove roots.

Yet another tree is often associated with these called the "black mangrove" though neither it nor the white is really related to the true mangrove. It is *Avicennia nitida*, a tree which carries on the business of growing these strange pneumatophores (as the quill-like growths are called) to a greater extent even than does the white mangrove. Here it often becomes a large tree and the mud beneath it, and for some distance away, is usually thickly covered with its quills considerably taller than those of the Laguncularia. It has the habit of viviparity, like the mangrove, but developed differently. Its large flattened seeds germinate on the tree, the two seed lobes or cotyledons being folded, and the roots do not greatly develop until after they have fallen.

There is a variety of vegetation along the mangrove shore and a little distance back in the

marshy ground, forming what is called the littoral. It has been supposed that we have two Annonas or pond apples, *Annona glabra*, with rather broad, glaucous leaves, and sepals and petals of about the same length; and *Annona palustris* with narrower, bright green leaves and the sepals longer than the petals. But it turns out that the young plants generally have the leaves of the former, this being sometimes true of vigorous shoots on large trees. I have repeatedly seen the two kinds of leaves on one tree and the flowers are extremely variable. Around the southern shore of Lake Okeechobee this tree forms dense, lofty forests standing on stilted roots like the mangrove. The wood is extremely light and soft and is used for rafts and floats for seines, while the roots are made into razor strops.

Two vines are common, *Ecastophyllum browni*, an immense sprawler, and *Rhabdadenia bifiora*, both of which reach to the tops of the tallest trees. Here too is a magnolia supposed to extend its range to the maritime swamps of New England, and a persimmon identified as the northern one but now considered distinct. It may grow in the edge of standing water but the northern species

is a strictly dryland tree. The small fruited calabash (*Crescentia cucurbitana*) is quite common in fresh and brackish swamps also in the high hammocks. In the more open spots, saw grass and a Kosteletzkya, which, in spite of its atrocious name has handsome pink flowers, are often found and sometimes patches of saw palmetto occur. Here in the rich, damp muck beyond the reach of forest fires it is a sprawler often reaching tree-like proportions. Two or three bulbous plants (Crinum and Hymenocallis) brighten the littoral swamps with their handsome white flowers and the two giant ferns (Acrostichum sp.) are intermingled with two lesser ones,—the royal fern and a Blechnum. The royal fern is perhaps the most widely distributed plant of Florida, being, according to Small, cosmopolitan in its distribution with the exception only of the boreal regions.

A large shrub is often seen,—the button bush (Cephalanthus) with opposite leaves and globular heads of white flowers. It is also a widespread plant, being found from Canada to California and south to Texas and Lower Florida. For some unknown reason it becomes a large tree in Arkansas, just as the mangrove attains a great size on

the shores of Biscayne Bay. A holly (*Ilex cassine*) with glossy leaves and lovely scarlet berries is common and a swamp bay which is very close to the upland one is also abundant.

The sandy or muddy mangrove flats along the southwest coast of Florida swarm with two species of fiddler crabs of the genus Uca. Some of them are prettily variegated with whitish, light and dark purple, blue, and red. The males have one large and one small arm, the former being held across the body and threateningly brandished whenever they are disturbed. The motion they make in so doing somewhat resembles the playing of a fiddle and hence the common name of "fiddler crab"; their fighting attitude and boxing movements have inspired the specific names of "pugnax" and "pugilator." In spite of all their aggressive show they are capable of inflicting but little harm. As one walks along it seems that he must crush many of them under foot, but somehow by scrambling about in a ludicrous manner they all manage to get out from under it. They eat minute algæ and particles of animal and vegetable matter which they find in the crevices of old stranded boats, timber, and decayed logs. This

they dig out with one of the claws (the male uses the small one) and pass to the mouth with rapid movement, reminding one of a hungry tramp,—a most laughable sight.

On the south and southeastern coasts the fiddlers are largely replaced by the great West Indian land crab (*Cardisoma guanhumi*) which makes its burrows in the muddy flats, and sometimes in summer in the hammocks and pine woods. Here in Florida this crab is active during the rainy season, and after showers it wanders about in great numbers. In the drier part of the year it is seldom seen though it continues to prowl about more or less at night. In the brackish mud flats, especially near the higher ground, one may sometimes see in a square yard of space a half-dozen of their burrows, varying in size from half an inch to the thickness of a man's arm. They pile the mud from below around the mouths of their burrows after the manner of the fresh water crayfishes. Without doubt this mechanical action on the soil like that of the earth worms helps aerate and prepare it for the dry land vegetation which is to come later. So it happens that these crabs so full of evil and so generally despised may, after all,

render some service in preparing the swamps for the occupation of men.

Usually about the first of September they leave their burrows in immense numbers and swarm over the dry land. They take possession of the yards and outhouses, and clamber up walls where they can find anything to cling to. It is sometimes impossible to sleep at night during this swarming season on account of the everlasting rustling and clattering. I have seen them cover the ground so completely during these migrations that over considerable spaces there was not room to step between them. It is believed they come out in this way to deposit their eggs in the sea, but I am more inclined to believe that it is solely for mating purposes as they range at these periods to a considerable distance inland. Shortly after this hegira they return to their burrows where they remain, comparatively inactive, until the next rainy season.

Certain species of small fish live in the shallow water of the mangrove swamps and are completely at home whether it is salt, brackish, or fresh. During severe northers the water may be blown out of the bays until extensive mud shoals become

bare. At such times these fish collect in the little pools left and in case the water recedes until they too are dry they burrow down into the mud, remaining there until the return of the tide without apparently suffering the least harm. It is quite probable that the ooze protects them from the cold and equally so that the process of breathing is partially suspended during this mud bath. I have taken them from the mud and replaced them in water when they immediately became as active as ever.

Back where the mud becomes firmer and near the meeting place of the swamp and dry land, we find two species of coco plums (Chrysobalanus spp.), our two Ficus (*F. aurea* and *F. brevifolia*), Baccharis, a weedy shrub or small tree, one or two of the Eugenias, and several of the trees belonging in the regular hammock,—outliers of the upland forest. One of the littoral trees of wide range is the buttonwood (*Conocarpus erectua*), a tropical tree not related to the northern sycamore of the same popular name. On the higher, firm ground it is usually a tall shrub, but in the least wet parts of the swamps it becomes a large tree and is, without doubt, one of the strang-

est vegetable productions of the earth. It has thick, elliptic, glossy foliage and at first it grows upright, a clean stemmed tree with rough reddish bark, attaining a diameter of more than two feet and a height of seventy. But it has a weak root development also probably a part of the scheme of its peculiar growth. Sooner or later it is sure to be blown over but this causes it neither injury nor inconvenience. Its wood is a dark, greenish brown, with a grain more confusedly locked than even that of the sycamore. Ye+ it is very brittle and in falling the trunk is much twisted and shattered. It immediately thrusts forth vigorous new growth from various parts of the prostrate trunk. This may be overturned again in a few years by another storm and the process repeated until one can hardly tell where the tree begins or ends. In many cases the growth of this strange vegetable is progressive and it seems slowly to work its way onward over the surface of the muddy soil almost like some living animal.

The trunk becomes in time very irregular and large, being composed of knotted, twisted, or apparently braided strands, often as large as a

man's thigh and with openings between in which one could thrust his arm. At times the outer living parts spring clear from the often decayed inner heart wood. These cavities then become partly filled with mold from decaying wood and leaves, and in them grows a strange cryptogamous plant (*Psilotum triquetrum*) which is rather closely related to the club mosses. It fastens its roots firmly to the tree, sometimes penetrating the bark and the half decaying wood and sends up its slender, branching, rod-like stems which bear scattered scales in place of leaves, and small, berry-like, yellow fruits. The creeping Polypodium (*P. polypodioides*) often covers the great, shaggy trunk, and *Blechnum serrulatum* as well as the two sword ferns already referred to are found with it. Occasionally several epiphytic orchids and a Peperomia make their home on the bark and altogether the buttonwoods become veritable aerial gardens.

As a result of being repeatedly overthrown these great trunks are sometimes twisted fully twice around and the brittle wood is so split up that some of it is detached and lies scattered on the ground, while the whole becomes so contorted

that it suggests the body of an immense serpent. If any living part of the trunk comes in contact with the soil it throws out roots and forms a new attachment with the ground and at such places fresh shoots come up. If two trees grow side by side, one will likely crawl over the other and they become locked in a death struggle. They always suggest colossal serpents or saurians. Occasionally some living part becomes detached and forms a separate tree; or a limb will be seen which is dead at the ground or at its junction with the main stem but alive a little above; it will eventually fall over and become a separate plant. I have traced a crooked trunk for sixty feet along the mud to find it turn and grow in a half erect position for twenty-five feet more. Towards the base, if it can be said to have one, parts or strands of the trunk lie dead and scattered on the ground, while others which are alive and growing will possibly, in time, form trees. Finally in the "wake" of the tree there will be a wagonload of dead and decaying fragments, some pieces being free, while others are attached to the ground by old roots. The entire plant seems to obey no law in its strange grotesque growth. There are a num-

ber of plants which grow at one end and die at the other; the common sphagnum moss (Sphagnum sp.) and the saw palmetto are well known examples. But I know of nothing which carries on such a system of growth and upon so extensive a scale as does the buttonwood; nothing so out of joint with itself, so whimsical and apparently without purpose. It is possible that this split up, braided growth may aid in aerating the tree. I cannot understand why it should be necessary for the tree to fall and live its life out in a reclining position unless it is that it permits it to live on and on indefinitely. No one knows how old some of these patriarchs are, but with no greatly disturbing influence I see no reason why they may not live many hundreds of years. If they are not immortal they come nearer to being so than any vegetable growth with which I am acquainted.

The work of building the littoral may be likened to the construction of a great edifice. The true mangroves break the ground, they lay the foundation at extreme low tide and construct the basement; the white and black mangroves carry up the lower part of the structure; the pond apples, buttonwoods, Ilex, and bayberries build the upper

part of it, and the Ficus, coco plums, and Eugenias put on the finishing touches which complete the building. The work goes on through the centuries and the mud flat that is submerged at every tide is slowly converted into high, dry land on which will be built the homes of men.

CHAPTER XIII

The Open Sea Beach

THE seashore is an interesting place even to those who have no scientific attainments nor taste for natural history. The abrupt change from the land to the illimitable stretch of sea is startling and stimulating. Along the shore line the restless surf, the rising and falling of the tide, the odd and strange forms of marine life, fragments of wrecks, and material drifted from foreign shores,—all have a suggestion of mystery and therefore fascination. Burroughs has said of one on the sea beach: "He stands at the open door of the continent and eagerly drinks in the large air." To the naturalist who knows something of its life; who can, by study of its living fauna, read the history of the land, the seashore is the most fascinating place in the world.

Along the west coast from Cape Romano to

Cape Sable there are beaches composed of silicious sand and the same formation is met with on the southeastern shore from Fort Lauderdale (the northern limit included in this volume) to Cape Florida. South of the two last mentioned capes the beaches are either rocky, broken coral, coral sand, or marl. The shores of southwest Florida are wonderfully rich in marine life, especially in mollusks. A little distance north of Cape Romano at Sanibel Island there is the most amazing development of marine shells I have ever seen.

When the wind blows strongly toward the land and the sea bottom is agitated for some distance out, shells, often containing the animal, crustaceans, fish, sponges, and a great variety of life are cast up on the shore. One of the strangest of these creatures is the horseshoe crab (*Limulus polyphemus*), a large crustacean that is seen from May to midsummer, at which time it comes up on the sand to lay its eggs near high water mark. The outline of the body is nearly round, being slightly drawn out behind: it has a long, spike-like tail, and the general color is brownish or chocolate. There is only one other species of the genus known and it inhabits the Malay Archipelago. Limulus

reaches back to Permian time, and allied forms are found in the Silurian rocks. The shield really consists of six segments which are soldered together but are separate in the embryonic stage. It has six pairs of appendages, the two forward ones acting as antennæ, the bases of the others which surround the mouth being serrate. These serrations act as teeth or jaws and are used in seizing and masticating the food. *And these same appendages also fulfill the part of legs and carry the animal about!* There is a pair of large compound eyes near the center of the shield and a smaller pair forward. I have called this strange animal a crustacean but it has recently been classed with the spiders and is believed by some naturalists to be related to the scorpions. It bears some resemblance to the Trilobites of the ancient Paleozoic seas, and in the larval state especially suggests these long extinct forms.

Everywhere along the sandy shores of the southwest coast the ghost crab (*Ocypoda albicans*) is abundant, varying in color from yellowish white to pepper-and-salt and harmonizing perfectly with the sand on which it lives. When pursued it scampers along with astonishing rapidity, often

The Open Sea Beach at Cape Sable, Showing Ricks of Shells. The *Barbee* at Anchor

Photo by Dr. John K. Small

suddenly squatting down, and disappearing; so closely does it mimic the color of its environment that it generally eludes its enemies. Without doubt its common name was suggested by its ghost-like appearance. There are sand fleas (Orchestia) which burrow in the sand, and are as lively as the insect from which they are named, and the shore is sometimes almost covered with hermit crabs (Paguridæ) of a number of species. They live mostly in dead, empty shells, the tail being soft and provided with a pair of hooks at its end for holding to the home chosen. When, by reason of increasing growth, this crab finds its tenement too small it hunts for a larger one, and is quite indifferent as to what kind; it may sometimes go into a sponge or even the tube of a plant stem. Once on the southwest coast I was fortunate enough to witness a change of habitation. A good sized hermit in a shell of *Fulgur pyrum* was moving about among a number of dead shells, apparently with the feeling of a man looking at houses to let. At last it found a shell of *Polinices duplicata* which was larger than its dwelling but very differently shaped. It moved around it several times, peered into it, probably to see if it was in

good condition for occupancy, then it came close alongside, whipped its body quickly out of the old residence and into the new, after which it scuttled rapidly away.

On floating and stranded timber there are thousands of Lepas, a curious animal with flattened, bluish white, shelly plates which belongs with the barnacles. It is attached by a scale covered, fleshy stalk, and within the plates are the vital parts.

One of the commonest marine animals among the Florida Keys and the southeast coast is the Portuguese man-of-war (*Physalia arethusa*). It is really a sort of community of organisms united in one body. There is an elongated, doubly pointed, inflated sac, which keeps the whole afloat, and this is surmounted by a crest that acts as a sail. The float is filled with air and rests on the surface of the sea, while from it depends a mass of tentacles and various organs. These are attached a little to one side of the base of the sac near its broader end. According to Mrs. Arnold in her excellent book, *The Sea Beach at Ebb Tide*, these streamers sometimes attain a length of forty or fifty feet when the creature is

sailing along, and they act to some extent as anchors to keep the Physalia from being driven ashore. It can raise the narrow end of the float or sail and make it "come about" in the wind. Notwithstanding these safety devices millions of them are washed ashore and at once die. It is a favorite amusement along our shores to step on these air bladders to make them pop with a loud noise. Some of the tentacles are covered with stinging or lasso cells which inflict severe pain on any swimmer who ventures among them and they doubtless, by this means, paralyze their prey. There are also locomotive and reproductive tentacles and still others which appear to have nutritive functions. They are among our strangest forms of life and are glorious objects when seen floating on the sea, the whole being a rich violet or blue with iridescent shades. With the Physalias are associated the Vellela (*V. limbosa*) which is also richly colored with shades of violet. It is also a compound animal with an oblong float and diagonal sail.

The commonest bivalve mollusk of the southwest coast is *Spisula similis* with a triangular, whitish shell that attains the length of three

inches. It is believed to be a dwarf variety of *Spisula solidissima*, which the collector will find in just as great abundance from Cape Hatteras northward. It is probable that on account of climate our southern form is less robust and brighter colored than its northern relative. On the other hand *Venus mercenaria*, the common hard-shell edible clam of the New Jersey and Long Island coasts, reaches a length of three inches, while in the bays along our southwest coast it becomes more than twice that size and attains the preposterous weight of five pounds. It is sometimes considered a mere variety of *mercenaria* and again is ranked as a species. In these two cases climate seems to work both ways. No doubt conditions in the north are more favorable for the Spisula than along the Florida coast, while the subtropical waters of the Gulf of Mexico exactly suit the large clam which grows only in a stunted form in the cold northern ocean. *Macrocallista gigantea* and *M. maculata* have large, beautifully maculated, polished shells; *Cardium magnum*, *C. isocardia*, and *C. lævigatum* are abundant, handsome forms, the former as large as a man's fist. There are elegant circular Dosinias

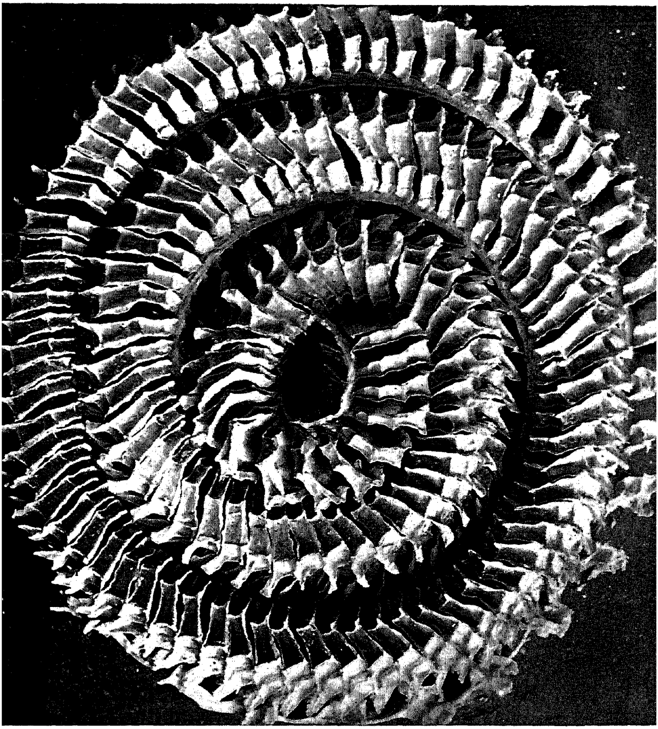
and a host of Tellinas and Macomas, with many species of Lucina and Pecten. One of the latter has the upper valve dark and the lower white, the one being colored by the sunlight while the other which lies in the sand or mud is not darkened. The same is true of many bivalves with a habit of lying flat on the bottom. When one attempts to catch this Pecten it rapidly opens and closes its valves, ejecting muddy water and darting away on the reaction.

Donax variabilis is another mollusk which depends on a trick to prevent its capture by enemies. In spring these lovely little clams are washed up on the sand by millions and for a moment they lie gleaming with a wonderful array of color—little gems of the sea. The shell is about an inch in length and beautifully polished, white, purple, rose, or yellow, often delicately rayed. Only for a moment do they remain on the sand, for in a flash they turn and dig themselves out of sight. Whoever catches them must not stop to admire their beauty, for if he does not one will be left.

Fulgur perversus, a giant gastropod mollusk, sometimes has a shell fifteen inches long and very solid. Most shells of this class are dextral, that

is if held with the spire end up the mouth or aperture will be on the right side of its axis. But this one almost invariably turns to the left,—it is perverse. Its curious egg cases are often washed up having many capsules filled with eggs or young and these infant shells all turn to the left. Then there are Pyrulas and Melongenas, and Polinices with very curious egg cases, and Crepidulas, shaped like a boat with a seat near the middle; there are lovely Conus, three species of superb Fasciolarias, and several small Olivellas whose polished shells gleam like gems.

I once had lived on the southwest coast for two years and though every time I collected on the open beach I found shells of the beautiful *Oliva litterata* they were always dead specimens. I had searched for them in all kinds of situations and I could not imagine where they concealed themselves. One day when I was on my knees gathering minute shells I saw something move in the sand. I reached out and from the end of a furrow pulled out a mass of soft white flesh nearly as large as my palm. It squirmed and contracted until finally I held in my hand a glorious shell of the Oliva which I had so long sought, and into



Curious Egg Case of *Fulgur perversus*, a Large Marine Gastropod
Photo by Dr. R. W. Shufeldt

which the entire animal formerly expanded had withdrawn. Its nacreous surface shone as though it had been varnished, bringing out in detail its wonderful color markings of blue-gray and brownish zigzag flames on a yellow ground. I shall never forget my thrill of delight. Then when I looked around I found numberless furrows in the sand and at the end of each was a living Oliva. They burrow to a depth of a few inches and come up to crawl about for food just at the surface. I had thought that so brilliant a shell would attract enemies, but whenever the animal comes to the top of the sand the shell is *covered entirely with its foot which is always the same color as the material in which it lives!* If the sand is white the foot is white, if it is gray or yellow or even black the foot corresponds in color!

In little bays or around temporary pools which have been left by the tide one often finds ricks of small, interesting shells and sometimes minute species are mixed with dirt and trash so that all must be carefully looked over, perhaps with a hand glass, in order to discover all the treasures. Again large shells sometimes lie in veritable furrows on this coast so abundantly indeed that a

train of flat cars might be loaded with acceptable specimens from one spot. Once with a friend I visited one of these beaches which to reach required quite a walk. We found the shore covered with fine shells and in a short time we had our sacks and baskets full, when I suggested a return to our boat. He looked wistfully at the heaps of beautiful specimens lying at our feet to be abandoned and then pulled off a knitted, seamless sweater and said: "It's a cold day when I leave such a lot of shells as these." We tied the neck and ends of the sleeves, and began to fill it. I never saw anything stretch like that sweater; the sleeves became as large as the original body. It stretched lengthwise and sidewise and when completely full we added my coat to the lower end and tied it on. The thing looked like the skin of some great animal stuffed with sawdust such as we used to see mounted in the old natural history museums.

If one goes about thirty miles south and west of Cape Sable to the Content Keys (among the nearest islands of the lower chain) he will find the marine fauna almost as much changed as though he had crossed to the Pacific. The Keys are a

region of corals and Gorgonias and but few things are to be seen among them which belong on the sandy beaches of the southwest coast. The Luidias or brittle stars of the west coast are replaced by the great Pentaceros; the sand dollars (Mellita) by a Metalia which looks like a corn pone. Instead of the harmless purple sea urchin of the western shores one cannot put his hand under a rock without danger of meeting the dreadful spines of the *Diadema setosum*. This urchin has a relatively small body which seems constructed for the sole purpose of supporting the most villainous armament of long, brittle spines which by merest contact drive deep into one's flesh and invariably break off, causing most intense pain.

The various yellow or purple sea fans which are found in great numbers in key waters are wonderfully graceful and remind one of living plants. Upon them are found certain mollusks of the family Ovulidæ the shells of which always have the color of their host. On the shores one commonly finds several mollusks belonging to the Littorinidæ, three or four Neritas, two or three of the Chitons, as many Purpuras and Siphonarias, all of which adhere closely to the rocks, and

though some of them are brightly colored they are generally so concealed by confervæ that it is difficult to see them. Under projecting rocks or among mangrove roots are two Cypræas or "micramocks" as they are locally called. These are queens among the mollusks on account of their size and the exquisite beauty of their shells. They are hard to find because the fleshy mantle of the animal covers the shell when the creature is active. There is a number of species of lovely Tellinas which are always beautifully polished, Codakias with orbicular shells, a couple of fine Cardiums and a red Pinna, among bivalves, and the great pink conchs, a handsome Murex, two or three helmet shells and as many Fasciolarias among the gasteropods. The fauna of the southeast coast is much like that of the keys but lacks some of the rock-loving species.

The curious Janthinas or violet snails are abundant in both of these areas and they are sometimes washed ashore in immense numbers. The animal exudes a glutinous secretion from a gland in the foot which hardens and forms a float filled with air bubbles, and in this the female lays her eggs. As these floats are attached to the Jan-

thinas they cannot sink and they live in communities a sort of pelagic life in the open sea. The shells are thin and together with the entire animal are a lovely violet color. At least four species inhabit our waters though *Janthina communis* is much the most common.

I once made a cruise in the schooner *Asa Eldridge* from Bradentown, Florida, to Honduras and on a Sunday morning while lying at Key West I strolled over to the north shore of the island. As I approached I saw from a short distance that it was everywhere a mass of glowing violet color and then I found it to be covered from below tide to well out on the land with fresh Janthinas. All the depressions and pot holes in the rocky shore were filled,—in places several feet deep. A vast community or gathering of them probably extending for miles had stranded the night before on the beach. It was the most astounding sight in the way of molluscan life I had ever seen and when I recovered from my surprise I proceeded to collect specimens. Lacking any receptacle in which to put them I used my handkerchief, then my new straw hat, then one pocket after another of my fresh white linen

suit, and when fully loaded I started for the schooner.

The day was hot, and soon the snails seemed to be melting. To my horror violet blotches appeared on my coat and trousers, spreading rapidly until the purple juice from the animals actually ran down and filled my shoes! I reached the city as the church bells were ringing and I tried to evade people by taking alleys and back streets but everywhere I met groups of churchgoers who stared at me in astonishment. They no doubt took me for an escaped lunatic. It seemed to me that Key West had a population of a hundred thousand and all churchgoers. Having run that gantlet and reached the vessel our crew greeted me with shouts and laughter. My smart suit was ruined, nor could I even wear it around the vessel without being derided,—but I had the satisfaction of cleaning up over two thousand fine Janthina shells.

The dissimilarity between the life of the west coast and that of the key region is due in part to the different character of the sea bottom, the one being wholly of silicious sand and the other of coral sand and rock. A more important

cause lies in the difference of sea temperature in the two regions. On the west coast there is a very gradual slope of the sea bottom for a long distance from the land and the shallow water is winter cooled until its temperature is lowered several degrees below that of the keys and the southeastern coast where the shores are bathed by the tepid waters of the Gulf Stream. This powerful current, of mighty volume and majestic flow, is unmodified by Florida winters. Even the shoals and shore water cools but little, hence the marine life is strictly tropical.

A considerable number of marine mollusks which inhabit the Atlantic coast of the southeastern States are also found in the Gulf of Mexico, but they do not extend their range to the extreme lower part of Florida. The water of the sea, as I have shown, is considerably warmer along the Gulf Stream than it is farther northward and as these are temperate and warm temperate forms they do not find this almost tepid water congenial. For a long time I could not understand this peculiar distribution, nor how these Atlantic coast mollusks could have found their way into the Gulf. Geologists assert that during late Tertiary

a sea passage existed across the State from lower St. John's River to Tampa Bay. If true we have an answer but the present contour of the land does not very well support the channel theory.

We do know positively that during early or middle Pleistocene time a considerable subsidence of the State of Florida took place. Dr. E. H. Sellards, formerly our State Geologist, has kindly outlined for me a map showing the shore line of the peninsula after the subsidence. It lay a short distance east of Bradentown, passing south into De Soto County, thence east (just north of the Caloosahatchee River) and northward in about the center of the present State. In a general way the territory east of the St. John's was submerged though there were a couple of long islands in that region. The ocean reached north along the southern part of the State almost to the 27th parallel, and as the climate was cooler than at present the opportunity was furnished for migration of Atlantic forms into the Gulf.

Everywhere along the banks of the Disston and other drainage canals in the Everglades the soft excavated Pleistocene rock is filled with the same marine shells now living on the west coast. One

might suppose he was gathering shells on the beach at Charlotte Harbor or at Tampa Bay but for the fact that the Disston material is semi-fossil. Heilprin dredged these same fossil marine shells in Lake Okeechobee. Among the shells *Venus cancellata* outnumbers all others and the beds have been named after it. *Venus mortoni*, as ponderous as it is to-day is common, and all the west coast Fasciolarias, Murices, Fulgurs, Cardiums, Lucinas, Macomas, Tellinas are found everywhere in these Pleistocene beds. In short they contain a complete duplication of the present marine life of the west coast; here the shells lie scattered across the State just as if they had fallen out of the ranks and died during their migration from the Atlantic to the Gulf. Since then the State has been elevated and extended nearly two and a half degrees to the southward, or to within a degree of the Tropic of Cancer. On its southern extension it has been crowded against the Gulf Stream, and the warm temperate forms can not exist in this tepid sea.

Going east through the canal from Okeechobee to Palm Beach one finds while nearing the sea a number of tropical marine shells (fossil) in the

Pleistocene deposits of this once very shallow sea. Such forms as *Codakia tigerina*, *Oliva reticularis*, *Marginella carnea*, and others are met. They inhabited the near-by Gulf Stream waters coming from the south and were carried for a short distance to the westward to meet the Atlantic species on common ground.

There are numbers of marine mollusks of the Lower Florida and West Indian region so closely resembling species of the Panamic area of the Pacific that only an expert can distinguish one from the other. *Strombus pugilis*, common along our shores, is very close to *S. gracilior* of the west coast of Mexico; our giant Fasciolaria is much like the smaller *F. princeps* of the Panamic region; *Vasum muricatum* of the Lower Keys is almost exactly like *V. cestus* from western Central America. *Purpura patula*, *P. floridana*, *Melongena melongena*, *Cardium isocardia*, *Cytherea dione*, *Venus listeri*, and *V. cancellata* of the Atlantic side are replaced by strikingly analogous species on the tropical Pacific coast, and the list might be greatly extended. According to Zetek, who has recently catalogued the Panamic mollusks, fifteen per cent. are common to both coasts and it is probable that

1500 species may be found in the entire region. Among the absolutely identical forms of both coasts is our common Atlantic oyster (*Ostrea virginica*) which has also been reported from the Gulf of California. No less than nine species of crabs are common to the tropical shores of both, and a large number of Crustaceans on one side of the continent are exceeding close specifically to an equal number on the other side. More than seventy-five species of fishes are common to the two coasts and doubtless the same approximations are true in other classes of ocean life.

The question will naturally be asked, "How did these marine animals get across a continent? Why should so many animals in one ocean closely imitate animals in another?" Obviously they could never have passed from one sea to the other around the north part of North America or by way of the Antarctic Ocean. Neither is it possible that birds or any other natural agency could have carried them across the Isthmus of Panama. During Miocene time there was a depression of Central America to the extent of opening a sea passage in the Panamic region. A mingling, though not very general and complete, of the life

of the two oceans resulted after which reëlevation of the area closed the strait. After separation conditions differed a little on each side; the water of the western ocean was cooler than that of the eastern and food conditions may have slightly differed. Species most susceptible to environment began to change, and so we have the cases of two forms so similar but not quite identical in the two seas. The animals least susceptible to environmental change modified but little or not at all, and hence the cases of specific identity on the two sides of the isthmus.

The flora of the seashore is extremely interesting. Along sandy beaches and dunes, especially on the west coast, a tall, handsome grass (*Uniola paniculata*) grows in great abundance. It has ample, nodding panicles of oval flower heads which look as if they were braided and keep long as everlastings. *Scævola plumieri* is an attractive low plant with thick, glossy leaves and pretty white flowers that are cleft to the base on one side. In sheltered spots a sunflower (*Helianthus debilis*) carpets the sand and displays its brilliant yellow flowers during most of the year. In moist places a succulent plant somewhat

resembling our garden portulaca (*Sesuvium portulacastrum*) covers the ground. This also lives along the seashores throughout the West Indies, and, according to Coulter, it grows inland through Texas to California, presumably in saline localities. Everywhere along our sandy shores the goatsfoot vine (*Ipomœa pes-capræ*) with its trailing stems, round notched leaves, and great purple flowers binds the loose sand together with its roots. A tall shrub (*Suriana maritima*) has yellow blossoms remarkable because all their parts are in fives,—five sepals, five, clawed petals, ten stamens, and five pistils. In many places a cousin of the cultivated heliotrope (*Tournfortia gnaphaloides*) grows in immense clumps bearing small white flowers in scorpoid racemes, which in English means they are borne on one side of stems which are rolled up like scorpion tails. On dry sand banks the Spanish bayonet (*Yucca aloifolia*) grows to almost tree-like dimensions. Its stiff, strong leaves are armed with terrible spines so it is better to admire at a distance its splendid head of tulip-shaped, white flowers.

Along with the Yucca the shore grape (*Coccolobis uvifera*) forms small forests. Often its branches

facing the sea are scorched by the strong, salt-laden wind and its head leans far to leeward. The large, stiff leaves are nearly round and almost as thick as cowhide leather. They are of a pleasing shade of green with red veins; in late winter they turn to unnamed tints of yellow, red, or purple,—autumn leaves without frost. The purple fruit grows in long racemes and is edible,—for those who like it. Of this tree Charles Kingsley has said, "This shore grape, which the West Indians esteem as we might a bramble, we found to be, without exception, the most beautiful broad-leafed plant we had ever seen." It is certainly a most striking tree and no one not an expert botanist would ever suspect that it belonged to the buckwheat family.

On level spots and in slight depressions at the line of extreme high tide a vast amount of trash often accumulates, and it is always interesting to dig this over for the many curious things it contains. In it may be found seeds of three species of Mucuna or sea bean which are often polished and worn for ornament. Rarely one finds a lovely carmine bean with a black border (*Canavalia rusiosperma*). An almost globular seed a full inch across is the fruit of a magnificent palm of South

America (Manicaria); when cut open the kernel is often as fresh as when it fell from the tree, but I have never been able to get one to grow. This palm has enormous entire leaves which may be four or five feet wide and thirty feet long; they are used to thatch roofs of dwellings. Then there is the common gray nicker bean (Guilandina) and more rarely the similar yellow one. The great brown seed of the Entada is usually very common. A variety of interesting seeds will be found in this drift and also the lovely shells of the violet snails associated with the curious, chambered Spirula. The pretty, loosely coiled shell of the latter is in life concealed within the body of the animal that develops it and which floats on or just beneath the surface of the sea. Though millions of shells are washed up on tropical beaches all over the world only a few fragmentary bits of the animals are ever found. On the southeast coast myriads of sponges are washed up. Among the commoner ones are the "finger sponges" (Euspongia) which occur in a variety of forms but consist always of a cluster of hollow "fingers." There are Neptune's cups (Hircina) which may hold from a pint to a bushel, and they vary as much in size

and form as do the finger sponges. Other sponge forms are long and slender, closely mimicking the Gorgonias or madrepore corals. There are also small, slender scarlet ones, and finally the Clionas which bore into and destroy immense numbers of shells. These ricks of sea trash upon the beaches are excellent natural history museums.

I know of no greater pleasure than that of a naturalist or collector, in the woods, the swamps, along the streams or upon the open sea shore. I pity those whose entire life and energies are devoted to money making, who have never revelled in the beauty and freedom of the great out-of-doors. I pity those with unlimited wealth, whose lives are spent in seeking any kind of a sensation, anything to consume the remorseless time which oppresses them,—who would give anything for a new or real thrill. Here on the sea shore are thrills without number and discoveries many awaiting the trained eye of the investigator. Here is opened wide the great book of nature, the gleaming page filled with wonders. Here too, is health, peace, and contentment, and a new life for the soul cloyed with the artificialities of an over stimulated civilization.

CHAPTER XIV

The Wonders of Ajax Reef

MOST of us are familiar with many beautiful landscapes of mountains or plain or of wide ocean reaches and some know the glories of a tropic night when the sky is brilliant with big stars that show their perspective, but comparatively few have gazed on the wonderful scenes beneath the sea. My first experience in actually seeing and going about among the living fish, corals, and other marine animals of a coral reef was an event of my life.

Ajax Reef is a little less than three miles off Elliott's Key, and is distant about eighteen nautical miles from Miami in a south by east direction. It is only a small part of the long series of reefs which I have referred to in the chapter on the Florida Keys. In places they are awash or show a bit above the sea in low tides and along them

on either side the water varies in depth from a few feet to six or seven fathoms.

In May, 1915 I was on the dredging yacht *Eolis* on which her owner, Mr. John B. Henderson, with a small party of friends were cruising among the keys. One night we anchored just north of Cæsar's Creek bank. On the following morning the sky was clear and the water of Hawk Channel was dead calm. Henderson proposed we visit Ajax Reef in the launch to set traps for mollusks and collect on the shoals. It was a wonderful run across the channel; standing in the bow and gazing down it seemed as though we were in an aeroplane, swiftly skimming through the air thirty or forty feet above the ground, so clear being the water we could see the bottom as through a plate glass. Only the "bone in the teeth" of the launch and the wake of white water following made us realize we were not actually flying.

In places the bottom was carpeted with a bottle-green growth consisting of a couple of grasslike plants, a Cymodoce or "manatee grass" and a Thalassia or "turtle grass." Both are washed ashore on our coasts in great abundance and are wrongly called seaweed. Here and there we saw

great rounded sponges of the size and shape of pumpkins (Hippospongia) and occasionally a large star fish,—a Pentaceros. In other places the bottom was of a smooth sandy mud without any growth on it whatever.

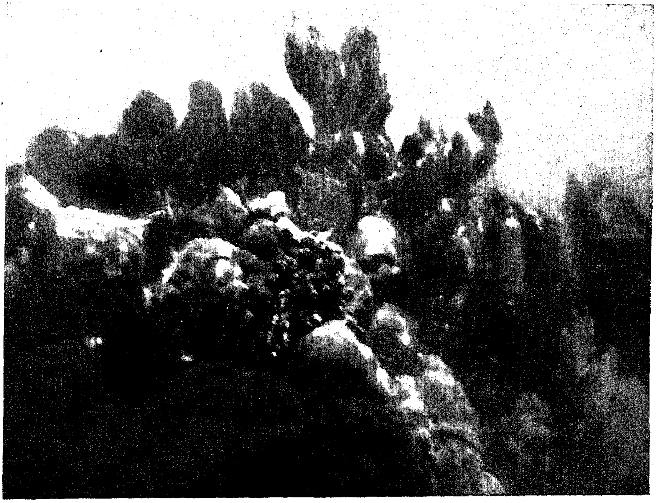
Suddenly as we proceeded rapidly along, the level floor of the sea changed and before us arose two rounded knolls reaching up to within seven or eight feet of the surface. Upon them grew thickets—I almost said forests,—of corals and Gorgonias or sea fans. They crowned the tops of the hillocks and occupied areas along their sides leaving spots of gleaming white, sandy bottom between. We were going in an easterly direction toward the morning sunlight which streamed through the submarine valley and into these masses of growth with a bewilderingly beautiful effect. In and out among these lovely thickets schools of the most gaudily and fantastically colored fish lazed and drifted.

The number of these fishes was amazing, their color and grace indescribable. Flashing just above the reef were hundreds of a small fish never over six inches long and shaped like the "pumpkin seed" of northern fresh waters, its color being of

a delicate yellowish green with five or six vertical indigo bands. This little living jewel bears the atrocious scientific name of *Abudefduf saxatilis.* Anyone who would blight the life and reputation of such a wonderful creature by calling it "Abudefduf" ought to be barred from naming any more of nature's creations. And its common names of "cow pilot" and "sergeant major" are not much better. We ought to have a society for the prevention of nomenclatural cruelty to animals.

Immense schools of the parrot fish (*Scarus cœruleus*), much larger than the first, raced through the water at terrific speed. It is rather stout in build and is of an almost uniform turquoise blue. Even more brilliant but rarer was a smaller fish of a dazzling red (Priacanthus?) which was much less bold than the parrot fish. It only appeared when someone disturbed it in its hiding places. Recently I have seen a statement of Professor W. H. Longley, who has made extensive studies of the fishes of the Tortugas, that the red fishes at that place are nocturnal. This would account for the fact that this species was only seen when driven out of its concealment.

There were ponderous brownish, variegated



Upper Cut. ***Abudefduf saxatilis***

Courtesy of the New York Zoölogical Society

Lower Cut. Coral Reef on Southeast Coast of Florida

Photo by Submarine Photo Company. Photo made under the sea

groupers which hung about the deeper spots among the gardens and shot through the water so rapidly that they looked like a trail of smoke. Among the remarkable forms was the "four eyes" (*Chætodon capistratus*), a lovely little thing of blue and brown markings, having a round, black "eye" surrounded by a white border on each side of the body just in front of the tail, the whole set in a smoky brown patch. There were two species of angel fish (Angelichthys) which are certainly angelic in their scaly robes of gorgeous color. There were "yellow tails," "pork fish," "porgies," "grunts," "snappers," and many others, but the queen of them all and perhaps the most gorgeous fish in the world was the rock beauty (*Holocanthus tricolor*). This superb creature is one of the Chætodonts or "butterfly" fishes, a group well represented in Florida waters and that contains a number of handsome species. It attains a length of a foot, has a high body, the ground color of which is jet black. The forward part of the body, tail, pectoral, and hinder part of the dorsal and anal fins are of a brilliant, deep gold; there are markings of rich orange on the dorsal and anal fins and around the gills, while

the mouth is blue. According to Jordan and Evermann's *Fishes of Middle and North America* this is not known from the waters of the United States but it really is not rare on the southeast coast of Florida.

We ran slowly over a diversified bottom, stopping now and then to absorb and revel in the strange and beautiful sight. What first strikes the visitor to such a reef is the wonderful color scheme, and then the amazing wealth of animal life. On land a few birds may be seen in an ordinary landscape; a moderate number of butterflies and other insects; a wild mammal of any kind is rarely encountered, but here are actually acres of living things closely crowded together. There are hills and dales of corals, and fields of sea fans, and everywhere the gorgeous unbelievable fishes.

The foundations of all this edifice of animal life are great rounded masses of corals, the Astreans, eight to ten feet across. Among them, and a little above in the structure of the reef, are other coral heads (Meàndrina) almost as làrge but having their surfaces cut into intricate ridges. They are called "brain corals" from the fact that their surfaces so closely resemble the convolutions

of a brain. Other species grow in masses, having irregular surfaces with wavy or scalloped borders—Agaricias, perhaps; nearer the top are the more delicate branching forms, the madrepores. The color of most of these corals is a rich, warm brown, but the exposed, growing edges are much lighter. Porites, sometimes in masses or developing into heavy club-shaped branches, are common. Then there are the millepores, corals resembling some of the more slender sponges, but growing in large heads.

The Alcyonarians, which include the sea fans, are everywhere in evidence growing out from the masses of coral and often surmounting them; the most abundant is *Gorgonia flabellum*, the ordinary sea fan, either yellow or purple. Almost as numerous and equally beautiful is *Gorgonia acerosa*, composed of slender branches instead of the lace-like network of the first. There are two other Gorgonias, one with heavier branches than *acerosa*, and from which the corky substance near the base falls away. All these Alcyonarians are reef dwellers and live only in warm waters. They are each a colony of polyps living upon a central, horny, flexible axis, thus differing from the true

corals which are wholly calcareous. The color may be purple, brown, or yellow, and they sometimes attain a height of several feet with proportionate breadth. They are among the most abundant and beautiful objects of the reefs. From the fact that they simulate the form and appearance of plants and possibly because they sway to and fro with the motion of the water like seaweeds, they are responsible for the name "gardens of the sea" usually applied to living coral reefs or patches.

Completely fascinated we drifted idly about, gazing down and calling attention to the warty, dull purple, sea cucumbers, the star fish, and the many sea urchins including the Diademas with their long, villainous violate-black spines. Certain species of sea urchins carve out holes in the solid rocks for their abodes. It has been thought these excavations were made by action of an acid which the animal exuded, but Alexander Agassiz maintains that the work is done mechanically, the animal chiseling out the rock with its teeth. It keeps turning around slowly cutting the hole or depression to fit the shape of its extended arms or spines. Some of the sea urchins bury themselves

quite deeply and eventually grow too large ever to escape, thus making themselves prisoners for life.

Growing on the bottom in shallow places about the reefs are beds of nullipores, some of which have quite the appearance of sea fans but their color is green and their structure stony. The commonest of these is *Halimeda tridens*, which is made up of angular, jointed pieces. Some of the numerous algæ growing on or in the vicinity of the reef are exquisitely beautiful in form and color. One of these (Acetabularia) looks exactly like a delicate, slender-stemmed but very green little mushroom. The stem may be at most three inches long and its little cap attain a diameter of slightly over half an inch. A colony of them on the sea bottom is a charming sight. Some of the algæ are red, others may be purple, brown, or intense bluish green. There is a wealth and diversity of life on this reef to keep one interested and filled with wonder for months.

But where are the mollusks or "shells," as they are commonly called? In passing let me say that it is no more proper to apply this term of "shells" to the mollusks than it would be to use it for lobsters or turtles. The *shell* of a mollusk is

merely the hard, outer coating or external skeleton that protects the animal. On a living coral reef mollusks are most conspicuous by their absence or by the invisibility of those present. It simply is not a favorable station save for a few species well concealed by their color markings. A dead reef, on the contrary, is very rich in mollusks but they are mostly carefully hidden. In a newspaper article I once read, the writer told of visiting a coral reef and made statements which made me think he had never seen a reef at all. Among other things he said that the bottom was covered with the loveliest, brightest, and most astonishing shells (mollusks), that they clung to the corals and sea fans, and fairly bespangled the submarine view as do the stars in the heavens on a clear night. Some of my conchologist friends would circle the earth to find that reef.

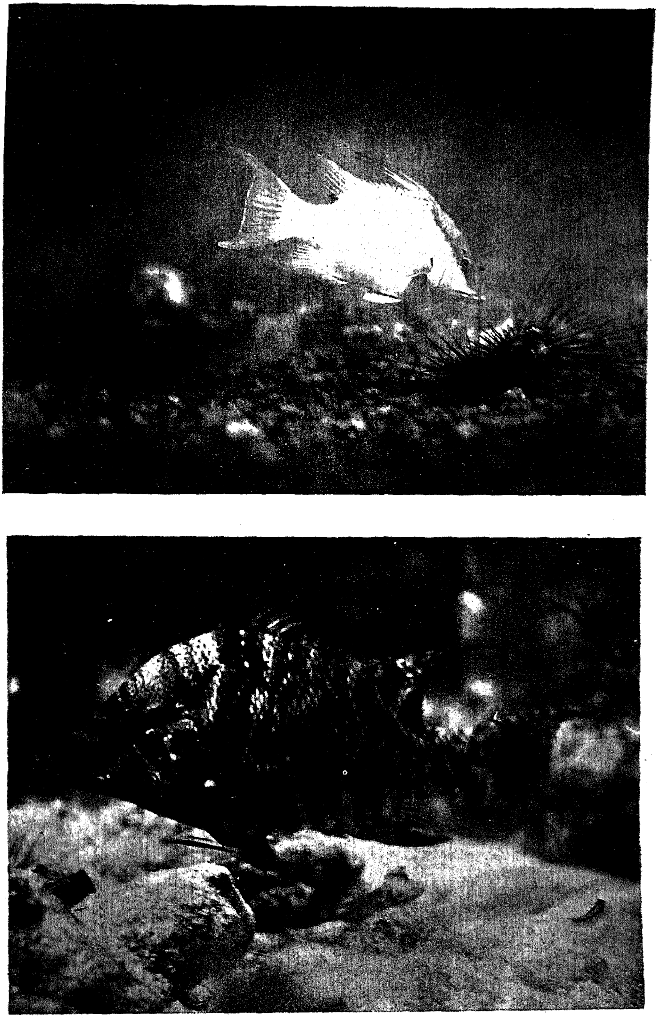
It may be well to say a few words here about protection among animals. Most of the members of the animal kingdom are either pursuers or the pursued, while many are both. It is the business of the first to seize and devour the second and of the second to elude the first. Hence the pursued have to resort to many tricks and devices to

avoid their pursuers and to defend themselves. In some cases the hunted ones so closely mimic their surroundings or imitate the appearance of some other animal that is never pursued, enough of them manage to escape capture to perpetuate the race. Most of the butterflies fly in zigzags, so that a pursuing bird is apt to miss them. Many have the under sides of the wings a dull or dusky color so when they alight and fold them they look exactly like the surface of the branch or tree trunk on which they rest. A great many of them (as well as other animals) have a nauseous taste and no matter how gaudy their colors may be the pursuers let them alone. When A. D. Brown, a distinguished conchologist, was collecting land snails in Haiti he noticed on the trees specimens of a lovely green and gold Helicina. He wondered why so conspicuous an animal should carelessly expose itself to its enemies. But one day he had occasion to put one in his mouth and he knew the reason at once; it was bitter as gall! Other animals are armed for defense; still others may be exceedingly swift of wing or foot or fin; all have at least some means of eluding their foes.

Here on this reef the gorgeously colored fish

that display themselves so recklessly owe their safety partly to their swiftness and to the fact that they stick pretty closely to shelter. Let a shark or barracuda appear and like a flash they are gone or out of sight. Some of these reef fishes have the chameleon-like power to alter their colors to harmonize with the bottom or the corals about them. Longley has made photographs of reef loving hog fishes (*Lachnolaimus maximus*) showing different color phases; a lighter, more uniform color is assumed while hovering over sand and a darker mottled tone and pattern when close to broken corals and among gorgonians.

Some reef mollusks have highly colored shells and their flesh is perfectly palatable. Now it would require a day for them to cover the same distance a fish would in two seconds, indeed some are fixed to their places and cannot move away at all. If these were conspicuously scattered over the floor of the reef, as the newspaper article set forth, such helpless creatures would not last a day; they would be exterminated between sunrise and sunset. Though the reef mollusks are comparatively few in species and numbers, they are nevertheless there but the ordinary observer does not see them.



Hogfish (*Lachnolaimus maximus*) which Lives among Coral Reefs and Changes Color in Accordance with that of the Bottom

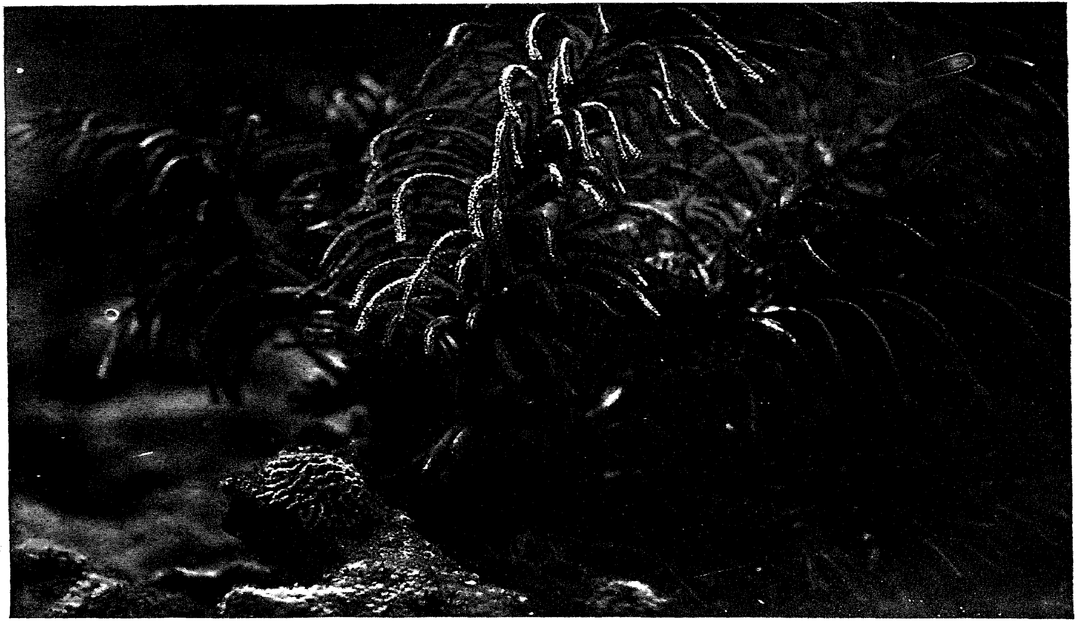
Photo by Prof. W. H. Longley

There are several of the Arcas, typified by the "Noah's ark," and all are attached to dead coral masses or other hard objects by a "byssus,"—a set of strong threads issuing from the foot of the animal and securely fastened to its anchorage. They are difficult to detect because they are almost always encrusted with algæ, hydrozoa, nullipores, or calcareous matter. There are three or four species of Lima with attractive white bivalve shells and an inside mantle border of very brilliant scarlet filaments, most gorgeous objects when exposed to view. They build for themselves nests of shell fragments, bits of coral and seaweed, so cunningly constructed that their enemies searching for them but rarely get them. There are three handsomely colored "micramocks" (Cypraæa spp.) that hide under the rocks and dead coral slabs and so manage to maintain a dark background against which their dark-colored mantles scarcely show. The Purpuras live on the reef rocks, even those occasionally exposed at low tide, but their pretty shells are most effectively concealed with confervoid growths.

As soon as a growing reef reaches the level of low tide the continual hammering of the breakers,

particularly during storms, breaks down the corals and the fragments left are rolled and ground about until they are reduced to sand and mud. The dead portions of a coral reef are made up of the most inconceivably rough and irregular rock mass with fragments of every size and shape scattered about. Among these fragments but chiefly *under* them thousands of mollusks and other marine animals take refuge and live in comparative safety, for no enemy is likely to overturn the rocks which shelter them. The crevices fairly swarm with life, crabs, sea urchins, star fish, mollusks, worms, anemones, hydroids, and a vast number of others. Break open any old mass of coral and in all probability it will contain a number of boring mollusks,—Botulas, Pholads, Lithophagus, Gastrochænas and Saxicavas.

In the sandy or muddy patches of an old reef may generally be found great white Tellinas and Codakias, Strombus, the graceful little Columbellas, Marginellas, and other interesting and beautiful mollusks in great variety, but all so hidden in one way or another that only a close search will discover them. There is a curious mollusk an inch or more in length (*Ultimus gibbosus*)



At the Bottom of a Tropical Sea, *Gorgonía acerosa*
Photo by W. H. Longley

that lives on the sea fans. The lips of its shell are rolled and folded in and it has a rather sharply defined ridge around its center. The base and a streak on the back are whitish while the sides are a warm fawn color. It so closely harmonizes with its host that, no doubt, it fools its enemies very successfully. Another related form (*Amphiperas acicularis*) is more slender and delicate; when it grows on a yellow sea fan it is also yellow, when on purple ones it is purple.

Among the Florida reefs life reaches its high tide of strenuous existence; it attains to its zenith, its noonday, its full glory. Nowhere is competition for food and existence more fierce than among these low rocks and in these coral sands. As a natural consequence here are to be seen and studied the most varied and remarkable devices for protection.

During a visit to Sand Key reef we all descended by turns under a diving helmet which Mr. Henderson had on board. This device consists of a brass hood which encloses the head while resting on the shoulders, so weighted and adjusted that the wearer can walk with ease on the bottom or study and collect his specimens while air is being

pumped down as into an ordinary diving suit. Through a glass plate one can get an excellent view about. With this aid one comes into the closest contact with the reef and its marvelous life; it was like entering into a new world—like visiting another planet.

My visit to Ajax is an unforgettable experience. It was my first sight of the marine knolls crowned with "gardens" of corals and sea fans, with sponges, hydroids, and algæ all seen through a clear luminous medium. What a riot of beauty! What a swarming of life! What hynotic motion of fish and swaying of vegetation. It is one of my most precious memories.

CHAPTER XV

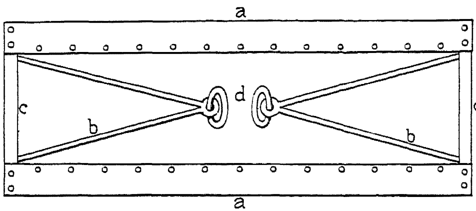
The Secrets of the Sea

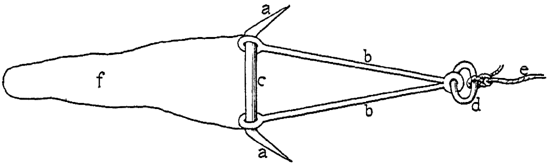
FOR a number of years past I have cruised and dredged during the months of May and June with Mr. John B. Henderson of Washington in his power boat the *Eolis* in and about the Hawk Channel and on the "Pourtales Plateau." These trips were made expressly for study and to collect the marine fauna. They have afforded me exceptional opportunities for observation and the gathering of data.

The Hawk Channel, lying between the Florida Keys and the reefs, has been described in another chapter. The Pourtales Plateau is a long narrow stretch of rock bottom lying some miles without and parallel with the Florida reef. It begins southwest of Sand Key and ends about opposite the southern end of Key Largo. It lies just within the edge of the Gulf Stream or between the 100–200 fathom lines.

The plateau is named after Count L. F. Pourtales who discovered it many years ago and by his dredging operations upon it has made it a classical ground to naturalists. In the Hawk Channel the water is more or less protected by the outer reef; the bottom is usually soft and supports in certain localities a rich and abundant marine fauna. The foundation of the plateau, on the other hand, is a recent limestone built of remains of the countless marine organisms that have lived upon it. Throughout the floor is an uneven complicated surface and it fairly swarms with life. It is, however, so very rough and broken that all dredging over it is most difficult.

The *Eolis* has a large cockpit aft which contains the sounding and hoisting machinery, and in it the dredged material is sifted, washed, and assorted. The dredges we use consist of two strong, parallel steel blades, either of which may scrape the bottom, and these are held in place by two heavy bars or standards, so that the whole forms a frame seven or eight inches wide and thirty inches to four feet long. The front parts of the blades are hammered to an edge in order better to scrape the bottom; a row of holes is punched along their





Outlines of Dredge. Upper Figure, Front View; a, a, Blades for Scraping up Material from Bottom with Perforations for Attaching Sack; c, c, Cross Bars; b, b, Arms; d, Rings to which Dredging Rope is Attached

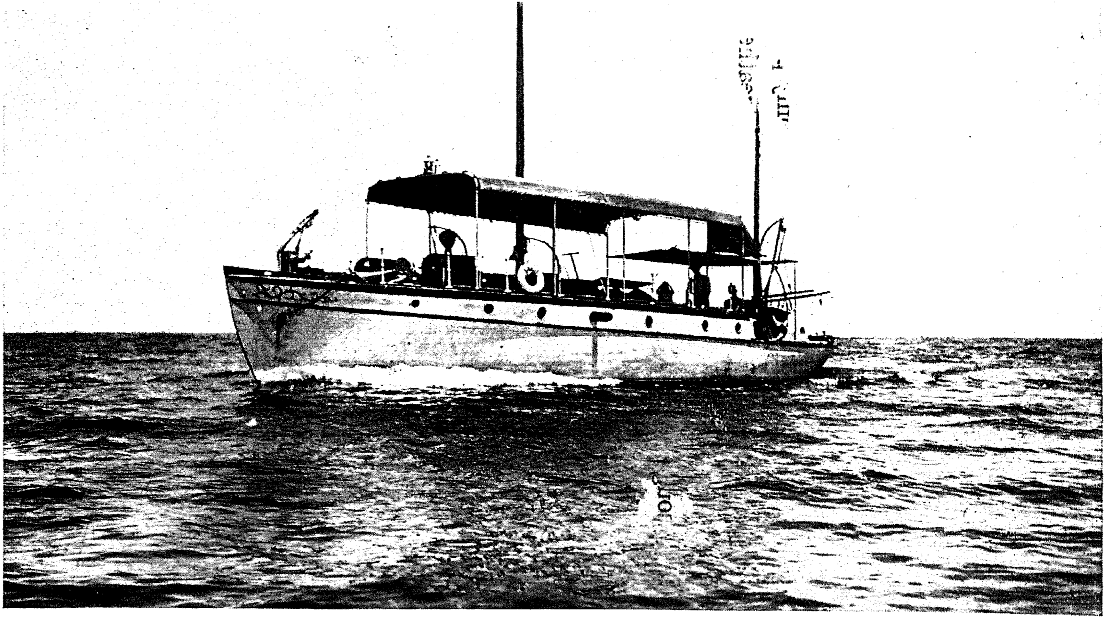
Lower Figure, Side View; a, a, Scraping Blades; c, Bar Fastened to Ends of Blades; b, b, Arms; d, Ring; e, Rope; f, Outline of Sack

rear edges and to these a heavy knit sack is lashed which drags behind and catches whatever is loosened from the bottom. This sack is protected by stout canvas lest it be torn as it drags over the rocks. The dredge is drawn by two pairs of round iron arms, the after ends of each being turned around the standards at each end of the dredge frame and they may be folded down over its mouth when it is not in use. The forward end of each pair of arms is bent into an eye and the dredge rope is securely fastened to one of these. The eye of the other pair is lashed to the rope with spun yarn which will break under a severe strain, usually allowing the whole to swing around and pull loose. The line used in dredging is ⅜ inch, of "plow" steel, and of special make for flexibility and strength.

If the dredge be hauled too rapidly over the bottom it will skip most of the material or perhaps bury itself in some muddy place and in case of meeting with rocks it will be badly damaged, if not carried away and lost. The work requires the greatest care and constant attention, especially on the plateau where the powerful Gulf Stream current and the waves of the open sea must be reckoned with.

A deep-sea sounding lead with concave base containing grease and attached to a piano wire is lowered before every dredge haul. This gives a depth record and a preliminary sample of the bottom.

With a boat the size of the *Eolis* it is only possible to dredge in the open sea when the weather is good and it is reasonably smooth. So we generally sought a harbor every night. When working on the lower end of the Pourtales Plateau we used Key West as a base. Dredging is not all fun and relaxation by any means. Often for days at a time the wind would blow too hard for outside work and we would be compelled to content ourselves with the light dredge inside the reef—generally with meager results. Given a suitable day, sometimes we would make haul after haul in deep water and get nothing. Occasionally the bag, as if possessed by the devil, would get fouled over the edges of the blades and come up after a long laborious haul empty as it went down. Generally an experienced dredger can tell by putting his hand on the rope what the machine below is doing. Again it would come up, after having badly fouled on the rocky bottom, twisted out of



The *Eolis*
Photo by John B. Henderson

shape, but possibly containing valuable material, and more than once we lost it altogether.

I think the gambling element must be strongly developed in all of us, for every time we made an unsuccessful haul the failure would seem to inspire us with confidence in better luck next time. Everyone on board is full of feverish expectancy as the dredge is being hoisted up after a good bumpy quarter of an hour on bottom. Far down in the water a faint cloud is first seen,—the mud and sand washing out as it is steadily drawn up. The cloud grows larger until at last the dredge itself appears, its white "skirts" flashing in the clear indigo-blue water far below. All are eager to get it aboard and emptied and inspect the contents. If there is a good haul it well repays for the disappointment of many poor ones.

The season of 1916 had been a bad one. Day after day the wind blew half a gale, so that we could do nothing even in the harbor. On the two or three occasions when we did get outside we were either driven in by a strong breeze springing up or we had bad fouls on bottom or "water hauls." Our time was drawing to a close and we hadn't made a single decent haul. One morn-

ing the sea was nearly calm, and Henderson declared he was going out to try his luck among the rocks of the plateau. "You'll lose a dredge if you do," said the Captain, but H. was firm in his determination; and out we continued until we were twelve miles south of Sand Key. The sounding line showed a hundred and twenty fathoms, rock, and the dredge was put over. In due time it was hauled up and on watching for it no cloud was seen, and we concluded that it had fouled or that there was nothing loose on the bottom. But when it appeared a most astonishing sight met our eyes. It was full to overflowing with a more wonderful quantity and variety of deep sea life than we had ever seen in all our previous season's hauls. It reminded one of the pictures of the bag carried by Santa Claus with toys sticking out in every direction.

Conspicuous among this material was a large number of specimens of "stone lilies" of the genus Antedon or Comatulids, belonging to the order of crinoids. The crinoids swarmed in the seas of early geological time, but their number has gradually decreased until only a relatively few species are known to inhabit the oceans of to-day. There

are two quite distinct groups of them existing in our seas; the Comatulids or feather stars, in which there is a lily-like head that is attached by a stem to the bottom while the animal is young, the head being severed in later life and swimming free. The dorsal part of the body carries a number of jointed, flexible processes by means of which the animal can attach itself to any firm object. In the other group, the true crinoids, the body remains fastened by the long, flexible stem throughout life. The former may be likened to a vessel moored to a buoy and the latter to one that is anchored.

No description can give an idea of the grace and attractiveness of these animals, which retain much of their beauty even when they have been torn loose from the bottom and brought to the surface. In life their long, elegantly jointed arms wave freely in the water as the currents move over them, and their resemblance to a bed of long-stemmed lilies is no doubt striking. In the dredge were many beautiful, strange, even grotesque crabs in great variety, green, brown, red, bluish white, and gray; there were equally interesting and curious sea urchins with spines of strange and fantastic

forms. No less than five species of Brachyopods or "lamp shells" were taken. Until quite recently these were very rare in collections, as comparatively few species inhabit shallow water, but since the days of deep sea dredging expeditions we know that they must be very abundant in places. Like the crinoids they were very abundant in Paleozoic oceans, but have been declining since. They possess bivalve shells which are always equal-sided but never equivalved, and are provided internally with a pair of coiled arms. Early authorities placed them with the mollusks while others believed them to be related to the worms, but modern systematists assign them to a distinct zoölogical class of their own. We dredged them in great numbers, usually in large clusters much like bunches of amber colored grapes and, as one of our party remarked, looking good enough to eat. Some of them were very large for lamp shells, being nearly two inches in diameter.

There were a number of exceedingly interesting single corals; one or two exquisite Hydroids; sea anemones, those flowers of the ocean, but so tightly closed and covered with foreign matter that at first we overlooked them. We got many

strange and curious worms and mollusks by the hundreds. Among the latter were elegantly fringed Murices with a long spire and many spines (*Murex beaui*), and a rare species of the same group belonging to a Pacific race. There were lovely Microgazas, whose depressed, iridescent shells look like flattened pearls; and then red spotted Volutes of three species, and elegantly variced Scalas (notably *Epitonium pernobilis*). The *genus Scala* is represented in collections by the well known royal wentletrap (*S. pretiosa*) from Oriental seas, which was formerly greatly prized on account of its beauty and rarity, fine specimens having at one time brought as much as two hundred guineas. But our perfect specimen of *Epitonium pernobilis* is as fine, and its specific name is aptly applied. It is one of the most beautiful shells in the world, and one of the rarest, as only three or four have ever been taken. Its pure white, rounded whorls, which scarcely come in contact, are well set off with numerous wide frilled varices, each of which ends in a point above, thus forming a perfect crown.

During the year 1869 a series of dredgings was made under the direction of Count Pourtales by the U. S. Fish Commission steamer *Bibb* in the

Strait of Florida. The mollusks secured were sent to Washington and later to William Stimpson in Chicago, a distinguished naturalist, who was to study and report on them. Before he was able to do so the entire collection was destroyed in the great fire. While the shells were in Washington Dr. W. H. Dall was greatly surprised to find among them a small Haliotis or "sea ear." These mollusks have their metropolis in the Pacific and Indian oceans. Hitherto Haliotis had only been found (one species) in the Atlantic along the western coast of Africa. The discovery of one of these mollusks in Floridian waters was a great conchological event. Later Dr. Dall published from memory a description of this destroyed shell, naming it *Haliotis pourtalesi* in honor of its discoverer. Years later the *Albatross* dredged a Haliotis in the Galapagos which Dr. Dall referred to this species with some doubt. About five years ago Mr. Henderson dredged a Haliotis on the Pourtales Plateau which was submitted to Dr. Dall, who unhesitatingly pronounced it to be co-specific with the original shell which had been destroyed. On comparing the Haliotis obtained by Mr. Henderson with the Galapagos specimen

it was at once seen that though much alike they belonged to different species. So Mr. Henderson renamed the Pacific shell in honor of Dr. Dall. The Florida Haliotis is quite attractive, the outer part being waxy yellow with patches of orange and the interior a brilliant pearl. As only this specimen dredged by Mr. Henderson and a few other fragments obtained by him are known it is one of the rarest shells in the world. Since it was obtained at a depth of ninety fathoms and all the dredging on this plateau has only yielded so few of them it is likely that it will always be rare.

Many of the shells of these deep sea mollusks are richly iridescent; others have a delicate shagreen, caused by an outer pearly layer of minute knobs or spines which gives them their sheen. Among shells so marked were several small cockles (*Cardium peramabile*), which in perfect condition looked like pearls. Some of the Gazas, which belong to the Trochus family, are most exquisite gems, and well might be worn as ornaments.

Perhaps the most astonishing thing we took was an Ophiuran or "brittle star," one of the Echinoderms, and related to the starfishes. The Ophi-

urans differ from the true starfishes by having a central disk from which radiate five slender arms which may or may not be branched. The species are mostly small but some of the specimens we dredged had the amazing length from tip to tip of opposite arms of two and a half feet! One might easily fancy them the hubs and spokes of Neptune's chariot wheels.

We were all delighted over these wonderful things, and Mr. Henderson declared this Ophiuran was new to science. He said, "Won't Professor Clark" (the echinoderm expert at the Smithsonian) "be astonished over this? He'll surely have a fit when he sees them!" In Washington H. hastened at once to Clark and proudly exhibited the trophies,—undoubtedly new and the largest in the world. Clark had no fit at all; he didn't even fall off his chair; in fact, he seemed but mildly interested.

Finally Clark observed quietly: "Your specimens are quite interesting, but we have others from the Pacific which measure about ten feet across!" It is related that H. required restoratives.

All the animals which came up alive appeared

dazed when dumped out of the dredge into the screen, and we may well presume that they were dazed. Even in this subtropical sea the water at a depth of a hundred to a hundred and fifty fathoms is cold, and only a half twilight reigns there during the hours of brightest sunshine. These creatures, suddenly snatched from the sea bottom, had been hauled up through six or eight hundred feet of water and diminishing pressure and thrown out into the hot air and dazzling sunlight. Some of them feebly crawled about in the helpless way that bees do when their smoked-out hive is rifled of its honey. The more delicate creatures were already dead when turned out of the dredge.

No description can give a perfect idea of the richness, variety, and strangeness of the animal life brought up in this and many subsequent hauls we made. We could not realize that such wealth of deep water life existed within but a few miles of Key West, and but a furlong below the deck on which we stood. Accustomed to the shallower water, fauna of the reefs and adjacent sea bottom which we knew, it seemed we must be collecting on some other planet where all life is different.

Many of these forms are "old fashioned,"

reminding one constantly of fossil species of the Tertiary age. In the quiet, cold, dark region where the deep sea animals live there is little change in environment from century to century, or from one geological age to another. As the struggle for existence is probably much less fierce than in shallow water or on the land it is not strange that a large number of ancient types belonging to past ages have persisted in their unchangeable surroundings.

For several happy days the weather was all we could desire and we continued our hectic dredging success. But at last we were reluctantly compelled to bid good-by to the Pourtales Plateau, but not before the Captain's prediction came true. Our best heavy dredge became hopelessly entangled in the rocks and no amount of maneuvering would loosen it, so we finally had to cut off one hundred and twenty fathoms of precious rope and abandon the whole thing.

What a thrilling thing it would be to go down to such a sea bottom and observe these animals in their homes. We can only at best scratch a little here and there and get a few handfuls of them; we can merely guess at their habits and environment.

No doubt there are very many forms that all our labor has failed to bring to light, but readily findable if only we could go among them; but we shall never be able to do this. The pressure of the water down there is so great it would crush any apparatus we could devise to protect us. Investigators differ as to the depth to which the light of the sun penetrates into the sea, some saying it is less than a hundred fathoms and others that it is twice that. Much depends, no doubt, on the clearness of the water and the directness of the sun's rays, but it is probable that at one hundred and fifty fathoms, the greatest depth at which we dredged, there is either total darkness or merely the faintest twilight at noonday.

One naturally wonders how it is possible so amazing a quantity and variety of animal life can exist in a region so cold and dark and below the limit of plant existence. On the Pourtales Plateau there is an overwhelming abundance of food, for the region lies just at the Tropic of Cancer, and as Grant Allen has remarked, "The tropics are biological headquarters." The Gulf Stream sweeps over it constantly bringing pure, warm water literally swarming with minute life. Most of this

is pelagic, that is, it floats and swims either on or comparatively near the surface and is carried about in the sea without fixed abode.

Besides those larger pelagic forms already mentioned (Janthinas, the Physalia or Portuguese man-of-war, the Vellelas and Porpitas) there are hosts of smaller Medusæ, and unnumbered millions of Pteropods, many of the latter having exquisitely beautiful hyaline or glassy little shells. Among these pelagic mollusks are the Hyalæas, the Creseis, which look like silvery needles, and the Cuvierias, whose tests resemble dainty little chalices. There is an infinite variety of Protozoans, and among them the Noctilucas which furnish much of the phosphorescence of the sea. The floating gulf weed (*Sargassum nutans*) bears a wealth of life, especially small crustaceans and mollusks. Many of these pelagic animals are very short lived, but they reproduce marvelously. According to Alexander Agassiz some of the Copepods, which are minute crustaceans, have no less than thirty generations in three weeks.

These pelagic animals are constantly dying, and it is aptly said there is always a gentle rain of food falling over the bottom of the ocean. Besides

that which falls as a "rain" a great amount of food stuff is washed out from the littoral regions, where it decays very slowly in the cold waters of the deeper ocean. It is stated on good authority that over wide areas on or near the sea bottom it forms a sort of broth, a veritable free soup kitchen. So the food is amply provided, and it is not necessary for the animals which swarm in this part of the sea to make any great effort to obtain it. It reminds one of people in the tropics lying under the trees and having fruit fall into their mouths.

It is probable that still other conditions favor the development of life in this intermediate "archibenthal" zone which lies on the border of the abyssal or profoundly deep regions. Many of these animals have been so gradually driven from the warm, sunlit shallows of the littoral region into the deeper waters that in all probability they find the want of heat and light no drawback to their existence. In some cases deep sea animals are blind, the eyes having been reduced to mere rudiments because they were no longer needed; in others the organs of sight are wonderfully developed, so that they probably see quite well in a dim light. Many of the forms of

this region are highly phosphorescent, and doubtless in places they are sufficiently abundant on the bottom to furnish enough light for others to see.

It may be wondered why in this darkness or semi-darkness there is any rich coloring among the animals, and the reason is not clear. There is much to be learned about the economy of color in organic life. Some of the more adventurous of the littoral forms may have migrated slowly into deeper water and, in other cases, animals of the shallows unable to compete with stronger forms, may have been driven to where conditions are more favorable. Where this migration has been recent, color and other shoal water characters (though no longer needed) would still persist. Many of these deep sea animals possess a peculiar red which Alfred Mayer says shows black in the depths, hence it may be protective. At all events the majority of mollusks we took on the Pourtales Plateau are neutral in color scheme, or develop a pearly sheen probably protective in a dim light or feeble phosphorescent glow. The most striking exception among our catch is that of the Volutas—but Voluta is a shallow water genus, and our three species are likely recent residents of the darker zone.

CHAPTER XVI

The Story of the Land Snails

THE land snails of Lower Florida, like most of its animals and plants, form a mixed assemblage of various origins. A few minute species are derived from the northern States; a considerable number probably migrated here from the Texas region, and perhaps half of our fifty species had their origin in the American tropics.

It has been generally held by biologists that life originated in the sea, from which it spread to the land; we have excellent support for this theory in our own mollusks. Several of our Littorinidæ, marine gastropod mollusks with spiral shell, gills and an "operculum" or lid that closes the aperture, live, for the most part, on land near the sea. One strictly gill breathing species (*Littorina angulifera*) becomes actually arboreal on the man-

grove trees, and only occasionally descends to the water to moisten itself.

In the warmer parts of the world a great number of mollusks have gone a step farther (Cyclostomidæ and allies), for they have left the sea altogether, and though they retain the operculum the gill has become modified into a sort of breathing sac or lung. At least four such species are found within the United States, doubtless derived from the American tropics. Most of our land snails have become pulmonates, that is they breathe by means of a simple lung, and they have not only developed this from the breathing sac but have in almost all cases lost the operculum.

Many of our terrestrial snails are provided with a remarkable set of calcareous "teeth" and lamellæ in the throat and aperture of the shell, and these, doubtless, serve to protect the animal from attacks of carnivorous beetles. In some cases this fortification is amazingly intricate, a veritable Cretan labyrinth, almost as complicated as the lock of a modern burglar-proof safe, and one might suppose that the animal would sometimes forget the combination and be unable to find its way out. Occasionally these "teeth" are crowded close together

Polygyra auriculata, the Aperture Remarkably Contorted to Prevent the Entrance of Predatory Beetles

and extend almost to the center of the opening, so that there are only narrow fissures left between them, while the sharp-edged lamellæ are almost as much convoluted as the lobes of a brain. It is interesting to watch one of these creatures emerging to crawl, for it seems actually to flow out of the aperture as if it were composed of very thick syrup. The teeth and lamellæ make deep impressions in the body as it moves out past them, but after getting by the constricted aperture the snail's body immediately resumes its proper rounded form.

That this armature is developed to prevent beetles from entering and devouring the animal seems well proven. Pilsbry has shown this by the evidence furnished by two groups of land snails of the genus Pleurodonte which inhabit the Andean region of South America. One of these groups called Labyrinthus, on account of the remarkable development of teeth and lamellæ in its aperture inhabits the hot lowlands of this area, where carnivorous beetles are abundant. The other and nearly related group (Isomeria) of the same genus is found only on the mountains where beetles are few. Their shells have only rudimentary teeth

and lamellæ. There is evidence to show Isomeria has developed from Labyrinthus. The aperture armature being no longer needed became dwarfed or rudimentary, or even wholly absent.

The land snails of the Northern States live on the ground, usually under leaves, stones, or logs, but in tropical and semi-tropical countries some of them are strictly arboreal and many others are partly so. In the pine woods of southeastern Florida several species hide under the rocks during the dry season, and often crawl a short distance up the trunks of the trees in wet weather. Along the sandy land of the outer beaches two forms are abundant which, during the rainy season, climb up the low scrub. One of these is a Cerion, with a cylindrical white shell which was probably derived from the Bahamas. Several years ago I was at the shore near the head of Biscayne Bay where I found dead shells of this species in great numbers, but no living ones. I searched in vain the bushes and grass. Finally I stumbled over a tussock of dead grass overturning it, and among its roots were hidden hundreds of the little fellows. As the weather was quite cold they had doubtless hidden in these half buried roots for protection.

We have a Euglandina, with a somewhat elongated form, which in northern Florida attains a length of three inches; the shell is a beautiful rose color. It is wholly carnivorous and a most aggressive mollusk. It attacks, kills, and eats any ground snails it meets, and if it cannot get anything else it will devour its own species,—an out and out cannibal.

Two species of Oxystyla (*O. reses* and *O. floridensis*) are found in the extreme lower part of our State, and they are among our largest and finest land snails. Both are strictly arboreal, the latter often having a shell an inch and a half in diameter and two and a half in length. I have never seen quite so large specimens of the former, which is much the rarer of the two, and is confined to the lower part of the Florida Keys. Both have glossy shells with a whitish ground and brown markings. Three species of Liguus belong within our territory, and they have shells almost as large as the Oxystylas; in fact occasional specimens reach a length of two and three quarter inches, but they lack in diameter.

Some of the shells of our Florida Liguus are among the most beautiful and richly painted of

any in the world. For the most part they are perfectly smooth and glossy, looking as if freshly varnished, or like finely painted porcelain. In the following list of their principal color schemes it must be understood that "revolving bands" are belts of color that spirally follow the growth of the shell from its apex to the aperture.

Pure white or whitish throughout.

White with brilliant green, revolving bands, usually narrow but rarely very broad.

White with bronze, or brown, or brown and green revolving bands.

White with yellow, orange, or, orange and brown revolving lines and bands.

White with broad, very dark brown, or black bands, the upper sides of which may be richly flamed.

Purplish white with brownish or rose colored bands and markings.

White with narrow green and broad orange revolving bands.

Rich rose, variously marked with darker color.

Yellow, from straw color to deep gold, sometimes shaded a peculiar brown.

Yellow variously banded with green, bronze, or brown.

Orange to orange scarlet, becoming darker at the aperture.

Dark brown to almost black, sometimes blotched with yellow or white.

Black or very dark brown, almost uniform color.

On the Lower Keys there is a form with yellow ground and a brown revolving band, also a broken band and flames of bluish. From Miami southward there is a race of Liguus with such remarkably varied patterns I am unable to describe it. The ground color may be golden through a number of shades to purplish brown. This is often banded with very dark brown, or it may have a wide semi-transparent belt which seems to be laid over the other colors. In places this has a greenish tint, in others it is more nearly blue. The whole shell has irregular vertical or sub-vertical markings, flames and zigzags of whitish yellow or some shade of pale brown and there may be narrow, revolving brown lines. A handful of these beauties is simply stunning, the assemblage of color is almost unbelievable. Among these chief color patterns

there may be infinite variety, the result in most cases of hybridization. Some of these intermediates seem to be crosses between half a dozen different forms and having imperfect color features of all.

One wonders why these shells are so richly painted, for evidently this brilliant color must be a decided disadvantage, if not actually disastrous. I have seen thousands of fresh dead shells lying on the ground which had been broken by the beaks of birds for the succulent animal within. Usually these were the more brightly colored specimens; rarely have I seen a dark, dull colored shell broken in this way, thus proving that death loves a shining mark. This apparently is an argument in favor of protective mimicry. The birds see the bright snails and destroy them; they do not see the dull colored ones. Do the brilliantly colored snails rely on their shells for protection only to be deceived?

Even to one of no especial interest in natural history the sight of large, handsome arboreal snails clinging to the trunks or branches of trees is startling, but to the enthusiastic conchologist it is simply thrilling; it fairly turns his head. At the

time of my first visit to Jamaica, Henderson and I were driving out from Kingston in order to have our first look about and possibly to do a little collecting. In passing a low scrub forest we saw a specimen of the fine *Oxystyla undata* attached to a limb of a near-by tree. We both shouted, and in a second had jumped from the vehicle and were racing toward it. We rushed through a hedge of villainous pinguin plants and up the tree; securing the prize; we discovered the tangle of thorny scrub woods were full of them. In half an hour we had two hundred fine specimens. We had made a fair and satisfactory exchange—two perfectly good suits of clothes ruined for the Oxystylas.

In the late summer and fall these snails lay their eggs, which are elliptical, about a quarter of an inch long, and have a calcareous shell. They come down from the trees to deposit these eggs in the ground, under leaves or even in decaying wood on the floor of the hammock. After the laying period many of the animals die. In late autumn the ground is sometimes strewed with fresh, dead shells of both Oxystyla and Liguus. In spring the eggs hatch and the little snails at once ascend the trunks of trees, where they

live on the minute algæ and fungi. During the cool, dry part of the year they remain dormant; "æstivate" as it is called. This is analogous to the hibernation of various animals in our northern winters, though it is probable that during æstivation in the tropics the vital functions do not so nearly cease as in the winter sleep of the colder parts of the world. The Liguus and Oxystylas exude from the mantle a mucus which hardens like glue and attaches the aperture so firmly to the trees that the shell will often break when one roughly attempts to remove it. Sometimes during warm, damp weather in winter the awakened Liguus partially dissolve this epiphragm, as it is called, and become for a time active, but when it turns cool and dry again they resume æstivation. In many cases the Liguus pass their inactive period on trunks or limbs of trees in open sight, but they generally seek to hide away in crevices or under the loose bark. This is especially true of the Oxystylas, and sometimes as many as twenty will be found huddled together on the inside of a hollow tree.

With the beginning of the rainy season, or a little before, the tree snails become active and the

shell grows rapidly, the first growth being thin and transparent. At the close of the rains the Oxystylas form a dark border around the mouth of the shell, but the Liguus rarely and then to a much less extent. The first season's growth may consist of from four to six turns or whorls, the second of perhaps a little less than one whorl, and after that the growths are short. By counting these rest marks it is possible to guess at the age of the snail, which under favorable circumstances probably lives four or five years.

All our Liguus and Oxystylas are derived from the American tropics, the former from Cuba, and the latter, no doubt, from a species of rather wide Antillean and tropical American distribution. In another chapter I have given reasons for believing that there has been no land passage between Cuba and Florida since the present life has existed. So far as we know the animals and eggs of these tree snails sink in salt water, and it is hardly possible that birds or hurricanes could have transported them. But in some way they must have made a considerable sea voyage, and the manner in which they have accomplished this is of great interest. These and other tropical snails must have been

transported by floating material; probably on the very trees which were their homes, in bamboos or as eggs in old or decaying logs.

Throughout the American tropics the giant bamboo (*Bambusa vulgaris*) grows abundantly, especially along streams. During times of flood great masses of it are often washed out and carried down by the current to be stranded along the valleys. After lying awhile the upper, thin-walled joints begin to decay and split up. The ground snails like to hide in cool, moist, dark places, so these dead bamboos become their favorite resort. C. B. Adams, who collected extensively in Jamaica, states that he found quantities of them in these upper joints. Perhaps during the next or a subsequent rainy season some of these prostrate bamboos are again washed away and carried out to sea, bearing their cargo of living snails. The heavier mass of fibrous roots holds a large amount of earth and stones which tend to sink the whole, but the thick-walled lower joints are still air tight and sustain the entire clump. I once saw in a small bay on the north side of Jamaica a number of these great bamboos floating in the water. There had been a torrential rain, and they evidently

had been swept down a much swollen stream into the bay. Their stems were standing almost erect, and they could have easily carried for thousands of miles a cargo of living snails at a safe height of five to twenty feet above the sea.

It is easy to believe that decaying logs in tropical forests might be a means of dispersing mollusks. Some of the ground snails live on such logs, and arboreal species as already stated lay their eggs in their crumbling surfaces. These logs are washed out in time of violent rains and carried out to sea like the bamboos. Living trees too with snails attached are torn out and swept seaward by the same means. From Cape Saint Roque to well up in the Caribbean the sea in many places is eating constantly into the alluvial shore and undermining thousands of acres of virgin forest. I have seen such timber being so undermined along the Honduras coast. Every hard storm would loosen a number of these and set them adrift. Through a long voyage some limbs might remain entirely out of water or only be occasionally immersed. Darwin states that he placed several species of land snails in sea water for seven days and that they suffered no injury whatever. On one

occasion I immersed a lot of Liguus in fresh water and after they had been kept beneath the surface for thirty hours I found nearly all were alive and able to crawl away as though nothing had happened. Some of them remained attached to the pieces of wood to which they clung when put in during the entire immersion.

Suppose that decaying logs, bamboos or living trees bearing snails or their eggs were thus carried out to sea from Cuba or other West Indian islands into the Gulf Stream; that after a voyage of some weeks or even months the whole were cast high and dry on the Florida Keys or the southeast coast of our State, there would be absolutely nothing to prevent them from crawling off the packet on which they took passage and establishing themselves as immigrants into the United States. There would be no custom house or need for naturalization papers.

Floating islands consisting of vegetation in large masses are carried to sea by tropical rivers. Such islands have been seen in the Atlantic as far north as Nova Scotia, and these undoubtedly carry land snails or their eggs. It may be urged that such a combination of favorable circumstances could

but very rarely occur, but time is long and snails are patient, and what might not happen to-day or this year or this century might take place a good many times in ten or twenty thousand years. There are certain keys in Lower Florida where all the conditions seem perfectly fit for Liguus, but the most careful search does not discover any trace or sign of them; it is probable that these snails were never landed on their shores in such manner that they could become established.

Having once become colonized on the keys or in some hammock near the shore on the mainland it is of interest to know how the snails pass from one island to another or from hammock to hammock. Mr. Charles Mosier, who has lived for several years on Paradise Key in the Everglades and who has had exceptional opportunities for studying the Liguus, tells me that he has seen crows carrying them in their beaks during flight with intention no doubt of eating them. One of these with eggs dropped on an island or in a hammock would most likely start a new colony. Hurricanes might also account for much local dispersal.

The arboreal snails live in the hammocks be-

cause in them there is shade, moisture, an abundance of food and opportunity to conceal themselves. These are lacking in the pine woods, and even if conditions were favorable the frequent forest fires would destroy them. I have seen Liguus crawling through the pine lands on several occasions during wet weather and at a considerable distance from any hammock. I have also seen specimens crawling directly away from my own little hammock out into the pine forest! Once while raining heavily I found a Liguus crawling on the ground among the pine trees more than a hundred feet from a hammock. I marked the spot and the next day, which was fair, it had crawled on several feet, climbed a weed and was apparently inactive. Again I marked its location and the following day, which was rainy, I found it fully twenty-five feet farther on and away from the hammock. At another time I found a Liguus beside an abandoned road in the pine woods and marked its position. In half an hour it had crossed the road, a distance of eight feet, which is not bad going for a snail. In the course of a rainy season then a Liguus could cover the distance between two quite widely separate hammocks. Of course

many, if not most, of these migrants are destroyed by enemies while on the march, and the majority escaping such an end fail to find any hammock and perish; but in the course of time some—even but one—must reach the goal. Thus they have crossed easily an open space in my grounds (formerly pine land) and become completely established among my cultivated trees a hundred feet from my hammock. Dr. Hiram Byrd informs me that when he bought his place in Lower Dade County there were Liguus on the citrus and other trees about his house which presumably had come from a hammock a quarter of a mile away.

There is something very courageous about these little fellows who leave their sheltered homes, their food, and companions and set forth to wander in the hostile pine woods in an effort to find a new hammock. They forsake all and risk all in answering the call of one of the strongest animal instincts—the founding of new colonies, the extension of their race.

Cuba has been occupied from one end to the other with handsome Liguus, though it is probable that none of them equal some of our forms in vivid coloring. Our entire stock has doubtless been

derived from that island and is the result of numerous migrations. Several of our varieties show close relation to certain ones of Cuba but some of ours seem very distinct from any Cuban forms.

The doom of our beautiful arboreal snails is undoubtedly sealed, for everywhere in our region the hammocks are being rapidly destroyed by man. The building of the railroad over the Keys has hastened their destruction and the Liguus and Oxystylas once so abundant there are now almost extinct. The very presence of the white man seems fatal to them and they fade away before him as most savage races have done.

Liguus fasciatus Varieties. Æstivating on Trunk of Jamaica Dogwood (*Ichthyomethia piscipula*). There are Two Forms Here, One Whitish, Banded with Brown, the Other Nearly All Dark, Reddish Brown. Long Key, Everglades

Photo by Dr. John K. Small

CHAPTER XVII

The Beauty of the Night

THE night to many is merely a period of darkness, a cessation from labor, an opportunity to sleep. To the naturalist it is a time when nature reveals some of her closest secrets, when she displays many charms withheld from the light of day. There is a nerve tension approaching exaltation produced by the tropic darkness, by the atmosphere of vagueness and uncertainty and by familiar objects bewitched into fantastic forms. To walk in one's grounds at night is to discover a new world; the trees are larger, their forms have changed and their well-known branches are shapeless blots against the sky. Unexpected noises startle and almost terrify one. The day birds have gone to rest and a new and different set have taken their places, as if Nature were working her employees in shifts. We may not see them but we are aware of their presence.

The night is peopled by busy little folk as intently carrying on their loves and labors as are those of the day. In February or March the chuck-will's-widow (*Antrostomus carolinensis*) appears, at first sparingly, but later abundantly. From early twilight until sunrise, rarely after, the males pour out their discordant song. I know no bird so earnest about securing a mate; hence their terrible clatter. They are like those who use many repetitions in their prayers that they may be heard for much speaking. One of these birds will repeat his "chuck-will's-widow" at a moderate rate for a long time and end by calling it as rapidly as possible, then for a little while he must cease from sheer exhaustion. One would think the female would capitulate rather than listen to such singing.

This bird almost entirely replaces here the much pleasanter voiced whippoorwill of the north. Those who have lived here a long time and watched the birds closely tell me they have never heard the whippoorwill, but it does in fact inhabit our part of the country. Once or twice a season I catch its lonely, plaintive call. The night hawk (*Chordeiles virginianus*) is not at all rare. When wan-

dering about in the darkness one of these birds may swoop down in its chase after moths and utter its loud, discordant "peent." It is quite enough to make one's hair stand on end. Rarely the screech owl (*Otus asio*) pours out its long wavering trill, which like the notes of most owls is decidedly mournful. Around old or abandoned buildings one may occasionally hear the squawk of a barn owl (*Aluco pratincola*) or possibly catch a glimpse of him as he flits noiselessly by hunting his prey.

The frogs are much in evidence at night and their cries are always welcome to him whose ear is attuned to the voices of nature, but their notes are not melodious. In his delightful *Natural History of Selbourne* Gilbert White says: "Sounds do not always give us pleasure according to their sweetness and melody; nor do harsh sounds always displease. We are more apt to be captivated or disgusted with, the associations which they promote, than with the notes themselves. Thus the shrilling of the field cricket though sharp and stridulous, yet marvelously delights some hearers, filling their minds with a train of summer ideas of everything that is rural, verdurous, and joyous."

In the north frog music is one of the earliest and

most delightful harbingers of spring, that of some species beginning before the ice is fairly melted from the streams and ponds; little of it is heard in mid-summer. Here such music is rare in the dry spring months but as soon as the early summer rains flood the low places the nights resound with frog music, and the clacking, snoring, screaming, and gurgling are heard from dusk to dawn. One cannot listen to these little songsters without feeling that they are intensely happy as no doubt they are.

Now and then the deep voice of the bullfrog (*Rana catesbyana*) is heard, a voice of such power that it sometimes carries for miles. To me its note, uttered at intervals sounds like "o-onk, o-onk," while to others it is variously interpreted as "br'wum," "be drowned," or "more rum." It is probable that its note varies a little in different localities (it has an immense range in the United States), and as animals do not have the power of articulating sounds distinctly their notes sound differently to different hearers. This song—forgive the term—is a sort of tremendous musical grunt, impressing one with the idea of unlimited lung power. No wonder that its voice is powerful

Oxystyla floridensis Æstivating in Hollow Tree. In Such a Location they are Comparatively Safe from All Enemies.
Hammock near Flamingo
Photo by Dr. John K. Small

for the creature attains a length of eight inches and is very massive. There are probably two other Ranas which help to make up this summer chorus in Lower Florida, one of them being a form of the common, widely distributed green frog (*Rana virescens*) the note of which consists of a single syllable repeated several times, a sort of "chock, chock."

In all probability a part in this chorus is sung by an animal that is neither frog nor toad but a sort of intermediate (*Scaphiopus holbrooki*). It is widely distributed in the Eastern and Southern States and usually inhabits temporary pools formed by heavy rains. It utters exceedingly clear sharp silvery peeps in rapid succession whenever it is disturbed. Abbott says of this wonderful musician: "The machinery for producing sounds is equal to an ordinary steam whistle and is apparently confined to the throat." The notes are so strong and clear that they may be heard from a train as it rushes by, and one is inclined to believe it to be the song of some bird.

Some of the music of this nocturnal serenade may be produced by the tree frogs. In the great chorus I have sometimes distinguished as many as

seven or eight different calls, though it is difficult to separate and identify them. In the brackish swamp I have occasionally heard at night a contralto frog note which sounds to me like "gul, gul, gul; gul guggle, gul guggle" slowly repeated several times. I know of no sweeter, more charming sound in all nature than the song of this frog, and it must be a stony hearted female that would be deaf to it. I have only heard it a few times and it's author is so shy I have never been able to discover him, nor can I learn its name though it is probably a Hyla. Whoever has the opportunity of hearing this low sweet call may consider himself fortunate.

One of the agreeable notes in the frog concert is the long-drawn and, to me, musical "mr-r-r-r-r" or "mree-e-e-e-e" of a variety of the common toad (*Bufo lentiginosus*). One cannot help wondering how so homely a creature can have such a delightful song. In fact the whole medley of this batrachian symphony is, to the real lover of nature, charming and thrilling.

During the late winter and early spring the fireflies, those stars of the fields, are very abundant in our hammocks and low grounds. Our com-

monest species is probably one of wide range in the United States (*Photinus ardens*), being found as far north as Indiana. In its case both names are very appropriate. "Photinus" means shining and "ardens" to glow or burn, so this little insect gets a good advertisement with each name. It is a slender, brown beetle, the elytra or wing covers being bordered with dull buff and the shield of the thorax extends forward so that looking at it from above the head is entirely covered as by an umbrella. The light-giving apparatus is located in two segments of the abdomen and is composed of fatty tissue, which is burnt without sensible heat, at the time of showing the light, the process being controlled by the will of the insect. In the male the light organs are more strongly developed than in the female, and the larvæ, which are found in damp places, also emit a feeble light. Kirby and Spence believed that this light is used to frighten enemies and others claim that it is a sex signal or perhaps displayed in rivalry among the males, but we probably do not understand its full significance.

In this species the flare is often slightly greenish but sometimes it is red or yellowish, varying some-

what in different individuals. Occasionally one shines out like a star of the first magnitude or a Venus among the planets. About a quarter of an hour after sunset they suddenly appear and the hammocks and lowlands twinkle with their little lanterns, but in an hour the illumination is mostly over and in another hour scarcely one is seen. After this at long intervals one individual may show its light and may be seen even during the dawn like some late reveler returning home from a debauch. The effect of their brilliant flashes in the dense, dark hammock is startling and uncanny.

The land crabs (*Cardisoma guanhumi*) though already mentioned deserve further comment here for they are especially active at night. They are most abundant on low ground near salt water. Their metropolis is in the West Indies but they are well established along the Florida coast from the vicinity of Palm Beach to Cape Sable. Here they occasionally attain a spread of eighteen inches from tip to tip of the claws though they reach a little more than that in Cuba. Most of them are a dirty blue; sometimes one is seen with a greenish or yellowish cast and rarely they are red and violet. They dig holes in which they live in low ground,

often going down below the surface of standing water. When these are abandoned they make the finest kind of breeding places for mosquitoes. During the rainy season, from May to October, they go out into the hammocks and pinelands, often a long way from the sea, living then under rocks or in hollows beneath the roots of trees. In wet weather they become diurnal and swarm out over the dry land even into buildings which are but little elevated above ground. They climb up the corners of rooms and get on beds and tables but the statement made by settlers that they occasionally play the piano may be considered a playful exaggeration. They climb leaning or rough barked trees to a considerable height and are very destructive to cultivated plants, shredding out their leaves with their claws and even tearing down large banana stalks. In every case where cultivated plants are mixed with wild ones they make their assaults on the former. I am positive they can tell a five-dollar exotic from one which cost a half a dollar, for they always destroy the more valuable one.

Their appearance is half repulsive and there is about them an air of impudence; they exemplify

the word "cheek" to an astonishing degree, yet they are very comical and ludicrous. I was once at the beach opposite Lemon City with a party for the purpose of taking a plunge in the surf. We changed clothes at the edge of the mangrove swamp and the mud being firm and dry we left our things lying on the ground. When we started to dress my socks were missing and after some search I found them both dragged into a near-by crab hole. One of them was just disappearing and in dragging it out I lost my elastic garter in the hole. One sleeve of my shirt was pulled into one hole and the other into one next to it and the rim of my felt hat had been drawn into still another. One of my companions had a shoe dragged partly in and he failed to retrieve a sock and both elastics. It might be supposed the crabs wanted these articles for nests but as their bodies and claws are very hard they certainly could have no use for a bed. I have dug into a good many of these burrows which slope slightly and are somewhat enlarged at the lower end, but have found no bedding so I am led to believe that our clothes were stolen out of "pure cussedness."

One claw or arm is greatly developed while the

other is dwarfed, and the great one may be either right or left. If molested they usually try to escape but when once cornered they pinch severely with the large claw. While the victim is writhing in pain the crab wrenches his whole arm loose and escapes. Sometimes when suddenly surprised they seem to become dazed and lose all power of offense or of retreat. At such times I have seen them stop short, apparently helpless, and allow themselves to be picked up even though within a few inches of a hole or other good place of concealment. It has been asserted that when the great arm is lost the small one begins to increase and eventually becomes the large one, but I doubt this. A minute claw grows from the socket of the great arm as soon as it is torn off, and it probably continues to increase to full size while the other remains as before. On summer nights their rustling and clattering is always to be heard in the hammocks and lowland and if one will watch quietly he will likely see a raccoon glide across some open space with one of them in his mouth, for "Brer Coon" is their mortal enemy, catching them in great numbers and cleaning out the last morsel of flesh from their carapaces.

Here along the edge of the hammock the moon-flowers (*Ipomœa bona-nox*) have climbed to the very tops of the tallest trees, forming a mantle of soft, luxuriant, cordate foliage. Sometimes a few flowers open before sunset but most of them bloom just as dusk is coming on. The great disk-like corolla is fully five inches across and the length of the whole flower is about seven inches. The twisted buds gradually unfold and become inflated, then they suddenly expand, much like the opening of an umbrella. If a puff of wind sweeps over them hundreds burst out at once as if touched by a magician's wand, and the effect of such a sudden display of loveliness is indescribable. All through the night they spread their glorious white salvers to the darkness, or perhaps to the moonlight, and then at sunrise they close up and fade, as Kingsley has said: "After one night of beauty and life, and probably of enjoyment." Yes, why not enjoyment? Why may they not in addition to life and beauty have some power of sense and feeling? On some plants the flowers last well into the morning, or if it is cloudy the greater part of the day. They open in undiminished numbers during cold nights.

In May and June several species of night blooming cereus blossom at dusk but they usually begin to wither before sunrise. As a rule only the climbing species do well here and two or three of these have become naturalized. On a pine trunk in my grounds a cereus, probably a hybrid, has sent several strict stems to a height of fifty feet and I have counted over twenty great flowers on it in one night. Its sepals are rich brick red, the petals satiny white, and it is exceedingly fragrant. On a single plant of *Cereus triangularis* I have seen fifty flowers each a foot in diameter and they transformed the live oak on which the vine grew into a miracle of beauty. No less than seventy-four of these blossoms were seen very early one morning on a plant which scrambled over an old rock pile.

The delicious, spicy fragrance which saturates the atmosphere of the hammock and even beyond it comes from the marlberry (*Icacorea paniculata*), a small tree which opens its clusters of pale, striped flowers in the autumn. In the winter it bears attractive purple berries which are much relished by the birds. Some of the cultivated flowers are also very fragrant at night. One of these (*Acacia farnesiana*), a small native tree often grown in

yards, has little yellow balls of stamens which scent a large area of a calm night. The night blooming "jessamine" is not a jessamine at all but a cousin of the potato and tobacco plants. Its greenish yellow blossoms open in the daytime and remain in perfection for several days. Until after dark they do not have the slightest fragrance; then some magic influence of the night suddenly opens their perfume cells and the wonderful odor pours forth. In its native region, the West Indies, this perfume is no doubt an invitation to certain nocturnal insects, inactive by day, to come for honey and incidentally to cross fertilize the blossoms. The fragrance of this Cestrum is so strong that a small spray of its blossoms will scent every room in a large house.

No words can give an adequate idea of the softness and brilliancy of the moon in Southern Florida and the same may be said of the stars. In the hammock the moonlight effect is wonderful as it filters through the dense foliage and forms varied patterns of light and shadow on the floor of the forest. Looking up through the trees it resembles the spray of an illuminated waterfall. Out in the more open pine woods the shadows of light clouds floating under the moon give almost

exactly the appearance produced by a passing shower. In the lowlands the effect of moonlight and shadow on the pools is weird in the true Edgar Allan Poe sense of that word. In places the light sifts through the trees and glimmers on the water; elsewhere there is still a faint, soft gleam, but under the heavy vegetation the black shadows are full of mystery.

The effect of the moonlight on the palms is bewitching as it shimmers on the glittering leaflets, and it is equally fine on the bamboos, enhancing their feathery lightness and grace more deftly than does the over-revealing sunlight. I well remember a night spent at the home of Professor Nehrling, of Gotha, Florida, some years ago. There was a full moon and a short distance from my bedroom window grew an immense clump of the majestic bamboo, *Dendrocalamus latifolius*. Its stems arose almost straight for fully fifty feet and then with indescribable grace arched slightly outward. I sat for hours at my window and drank in the intoxicating beauty of this stately grass, and it seemed to me in that magic light to be the most perfect specimen of the vegetable kingdom I had ever seen.

During the rainy season vast masses of cumuli or "steam" clouds build up on the horizon, sometimes reaching almost to the zenith, and these are especially noticeable in the earlier part of the evening. They are gray, lead colored, or even a dark, leaden blue in the shadow but in the light of a setting sun they show charming tints of whitish, straw color, or gold. Sometimes when they are piled up in the eastern sky they exhibit ravishing tints of salmon, rosy red, or violet. As the light fades from their more illuminated parts they change to bluish black. The effect of these immense masses of summer clouds is grand in the extreme.

Orion, the most magnificent of the constellations, is visible evenings from November to May. At the time when this group is on the zenith no less than eight stars of the first magnitude are visible in our latitude. The constellation Scorpio is almost equally splendid, a scorpion without a sting; one which inspires no dread. It occupies a great space in the heavens, looking like an immense inverted interrogation point. It is visible during the summer and when it is directly above the heavens are very brilliant. To the west of the

scorpion is the Centaur, a large group with a considerable number of bright stars so evenly strewn that one might imagine some giant had scattered them as a sower would sow grain.

The southern sector of the heavens is also very brilliant because of a number of stars of first magnitude not visible in the Northern States. In the lower part of the Centaur are two superb stars, Agena and Bungula, which show finely low down in the Southern sky in late spring and early summer. It is probably not known generally that the Southern Cross can be seen in its entirety in this region in May and June. With a clear horizon Acrux, the southernmost and brightest star of the Cross, is visible here for a short time during the evenings of these two months. The group is a little disappointing as it is not a very perfect cross but rather a slightly irregular diamond. Acrux is a splendid object; there are two stars of the second magnitude and two lesser ones. Canopus is a fine star in the Southern sky and so too is Fomalhaut, only seen in autumn,—in the Southern Fish. This is not in the zodiacal constellation Pisces which has two fish tied together by their tails, the ribbon being bespangled by

small stars. Besides these there is a Dolphin, the Swordfish, and a group called Pisces Volans (the Flying Fish), the latter far down in the Southern skies. For a dry region the firmament seems to be pretty well stocked with fish.

There are always some of the planets visible and one may watch with interest their motions and the changes of some of them from morning to evening stars and the reverse. The stars become one's companions and friends when once one has learned their names and positions in the heavens; they exhibit an ever-changing panorama of interest and beauty. During the wanderer's nightly walks he visits with them and is never lonely when their kindly light shines on him. By them he is able to tell with considerable accuracy the hour of the night.

The darkness in the deep hammock is so intense that it seems to be in blots; like that of Egypt it can be felt. The sensation one gains as he gropes about in it is one of helplessness and semi-terror; at every step his nerves tingle. One hears strange sounds startling and affrighting; the whole environment is uncanny. I frequently awaken in the night and, unable to sleep for a time, I some-

Great Blue Land Crab (*Cardisoma guanhumi*) **Not Full Grown**
Photo by Miss Marion Roper

times wander out into the grounds to see what is going on in the darkness. On one occasion I went into the hammock at about two in the morning and while standing in a small open space listening to the frog chorus I heard a noise in the dense forest as though some large animal were rushing through it. It seemed to be moving rapidly in my direction and from being startled at first I became frightened. I feel sure that what hair I have stood on end and I was strongly tempted to run even in the inky darkness. But before I could make up my mind to do so two men with guns stepped into the open space where I stood. In such a voice as one has in a nightmare I managed to call out "Who are you?" and when they heard me they were as frightened as I. Then they told me they had been in the swamp to the northward hunting a wildcat and were on their way home. When I had somewhat recovered from my fright I recognized them as two of my neighbors and we had a good laugh over the adventure.

I love the night with its silence, its strange sounds, its beauty and mystery. It has an infinite attraction for the devotee of nature: all that he sees, hears, and feels are so different from the

experiences of the daytime; he seems to be in another world. Whatever differs from the ordinary may appeal to one's fancy and produce a thrill. Muir wrote one of his finest chapters as the result of a day's tramp in a pouring rain, and one of the most fascinating of William Hamilton Gibson's sketches, which he illustrated with his wonderful drawings, was an account of a night spent in the great out-of-doors. Much of the wonder and beauty of the night consists in what is only half seen, in what is partly suggested, leaving the imagination to do the rest.

It is then largely because of the stimulation of the imagination that the night is so wonderful. Under its spell we create a world of our own and revel in the make believe—like the children of a larger growth that we all are.

CHAPTER XVIII

The Survival of the Fittest

THE very fact that tropical life exists at all in Lower Florida is in itself a proof of the survival of the fittest. It all had to cross the ocean and on its arrival establish itself despite the competition of forms which already occupied the region. In addition to this the environment in Florida is not so congenial as in the regions from which this life migrated. The lower part of our State has a colder climate than any part of the American tropics which lies near the level of the sea; food is not so abundant and our soil is generally poorer. Land birds of weak flight, reptiles and batrachians of degenerate type, or mammals and insects of uneconomic habit would be almost entirely shut out. The seeds of a great number of plants sink in salt water, and some that float lose their vitality in the sea. Only the strong and fit, those with great vitality, could ever

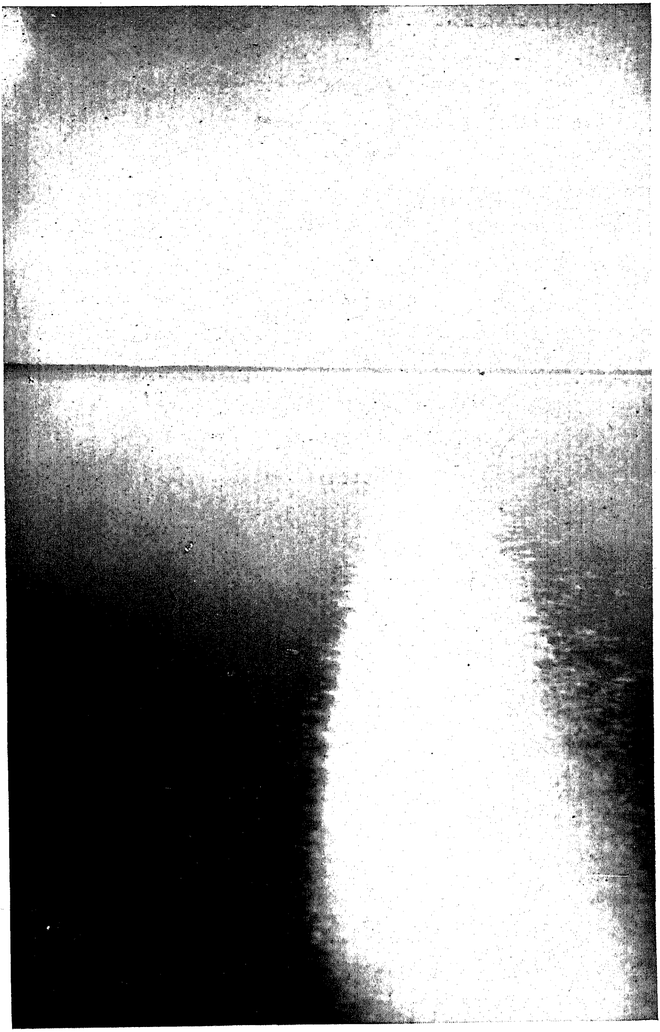
have become established on our shores. On the other hand life which had no doubt previously migrated to the lower end of our State from the northward met that from the tropics and a battle royal for a place and food began and has ever since been waged with never-ceasing relentlessness.

We have two species of Ficus in Lower Florida, both of which have somewhat similar habits, but one of them, *Ficus aurea*, quite commonly begins life as an epiphyte, while the other, *Ficus brevifolia*, usually grows throughout its life in the ground. They belong to a family which is abundant in the tropics of the old and new worlds, and containing a number of species that live on other trees and choke them to death, hence they are called "stranglers." The floor of the hammocks or tropical forests is a dark place, where even at noontime of the brightest day there is but a limited amount of light. If the seeds of the Ficus fell upon it they would doubtless germinate on account of the heat and moisture, but in the dim, crowded forest they would stand little chance of ever becoming trees. So the strangling figs resort to a cunning trick. Their fruits are eagerly devoured by birds and when they alight on the branch

of another tree the indigestible seeds may be passed out and lodged in some cavity or crevice of the bark. Ordinary seeds would never germinate in such situations and if they did the young plants would soon die because of lack of nourishment. Those of the Ficus sprout and begin to grow on the tree where they are lodged, and the radicle develops into a tiny root which creeps out over the surface of the trunk or limb to which it is attached; the plumule becomes a stem bearing the ordinary Ficus leaves, and in a short time it is a strong, healthy plant. It is not a parasite for it does not draw its sap from its host; it is at first an epiphyte and it seems to cling with a sort of loving dependence to its supporter. Often the foliage of the two looks so much alike that the uninitiated would never suspect that two different trees were growing together, and I have sometimes fancied that this was a sort of cuckoo trick by which this interloper sought to deceive its host and pass itself off for a part of it.

One root follows after another and when they reach the ground they "make fast," as the sailors say, and soon become "taut as a bowline." Then lateral roots spring out and cross the perpendicular

ones, "marrying" wherever they touch each other, and soon the whole system becomes a closely cemented network. In some cases the falling roots turn once or more around the trunk of the host before reaching the ground. At first they do not seem to injure the embraced tree but later when they have fully enclosed it the leaves turn yellow and it slowly dies. There is no funeral or any sign of mourning in the dim forest; the Ficus deliberately goes on covering the dead trunk with its terrible roots. Soon boring beetles invade the trunk, which on account of the heat and moisture has already begun to decay. In a short time there begins to fall from between the enclosing roots what looks like sawdust which forms a mound at the foot of the Ficus. Now the usurper begins to fill in the space (which was occupied by the host) with its own growth, becoming for a time an endogen, and later the Ficus becomes a solid trunk standing erect and looking much like any ordinary forest tree. The whole process, which is somewhat complicated and requires many years for its completion, is initiated and carried out in order that the fig may have an opportunity to begin life and have a place in the forest where there is plenty of



Actual Moonlight Scene, Looking across Biscayne Bay from the Pavilion at "The Sentinels." A Two Hours' Exposure

Photo by Mrs. Reba Minford

air, room, and light. It looks very much like the result of planning and reasoning, of a deliberate selfishness of the worst sort. The helpless tree which is being crushed and strangled in the embrace of the fig, the long, lithe roots thrusting themselves into every crevice, wrapping tighter and tighter about their victim, remind one of Laocoon and the serpents. The fig is not content with using the host to elevate it into the region of light and give it a start in life, but it utterly destroys its benefactor in order that it may use the exact space it occupied.

When they have plenty of room our Ficus or wild figs often reach gigantic proportions. They frequently come up in the pineland, especially about dwellings or cultivated land, and grow rapidly, but they are so different in appearance from the hammock specimens that no one would suspect that they were the same species. In the latter locations the tiny roots of *Ficus aurea* usually grow singly, while in the open those of both trees are in fascicles which often become tangled and braided by the action of the wind. At last they become consolidated into great, knotted ropes. The lighter colored growing points are

more or less sticky during damp weather and when they are thrown against the trunk or each other they adhere and are soon solidly joined together. They reach out and spread as they clutch like a many fingered hand; in fact they are uncanny things for they appear possessed of nerves, muscles, and a sinister intelligence. The layers of growth, largely made up of these fascicles, are far more locked and complicated than those of a northern sycamore. These roots may be thrown against fences and buildings, and if so they catch on and may hang in fantastic loops, or they drop into the ground and in time the great tree becomes a veritable banyan.

The struggle for existence among plants begins with the seed and never ends until death. Nature has to be wonderfully fecund for not one seed in a hundred, or in some cases a thousand, becomes a mature plant. Down on the mud flats I have seen the ground covered so thickly with young seedling Laguncularias that they actually touched each other. There were plants enough to make a hundred acres of forest could they have been properly cared for. A visit to the same spot a year later showed only here and there a young

plant struggling to get up through the thick scrub and weeds. In another year nearly all were gone, swept away by high tides, devoured by insects, killed by disease, or choked out by other vegetation. The same is true in the hammock where thousands of plants of the Ocoteas, Eugenias, papaws or live oaks come up in a single season. They all run the gantlet and at best only a few half starved plants survive for even a few years. By and by some old tree which has occupied a large space dies and falls, leaving an open spot, and a single seedling which is a little stronger or more advantageously situated than the rest soon occupies the vacant area and keeps down all the others. Thus nature wastes an almost uncalculable amount of energy.

Is it any wonder then that with the fierce competition for space, light, and opportunity in the forests the weaker plants are driven out into the swamps, into the water, or onto the trees to live as epiphytes; anywhere that they can find room and make out an existence? Is it strange that they seem to resort to all kinds of schemes which will give their seeds a chance to grow and reproduce their species? The epiphytes have used

several cunning devices wherewith to establish themselves. The seeds of orchids are very minute and can be borne long distances by the wind. Those of our species of air pines (Tillandsia, Catopsis, and Guzmannia) are provided, with a tuft of silky filaments, much like the down on a thistle, the whole so light that it almost floats in the air. Whenever these are blown or drift against the limb or trunk of a tree the roughened threads are pretty likely to catch and hold. The wind and rain beat them down against the bark until the seed touches it, when without any soil or extra moisture they germinate, forming at first a few fleshy leaves like an aloe, and at the same time sending out roots which cling to their support.

On some of the trees in my hammock I fastened small specimens of a giant air plant from Cuba which has hard, indigestible seeds imbedded in a sweet, sticky pulp, the whole contained in a sort of capsule. In its native land the birds eagerly devour the fruits, a part of which often adheres to their beaks, claws, or feathers. When they alight on other trees the sticky mass may come in contact with limbs or bark and adhere, or the seeds are passed through and lodge where they can grow.

Strangely the birds here have not learned that the fruits on my imported plants are edible, though they have been growing here a number of years.

The common long or Spanish moss which is placed in the genus Dendropogon hangs from the branches of trees over wide areas in the lower south. In addition to its means of propagation by seeds which are borne on air currents, its long, pendant streamers are constantly being torn off and carried for some distance by winds which lodge them on the limbs of other trees. Whenever they are so landed they throw out roots from any part of the stems which come in contact with the wood and a new plant is born. This is a very common and efficient means of distributing this strange Bromeliad.

We have several kinds of native plants which are not at all dominant in a wild state but which become decidedly aggressive and assume the character of weeds in cultivated ground. Among these are two or three species of sand burs (Cenchrus) and a Boerhaavia, all of which are provided with burs and are among our most pestiferous weeds. Almost as soon as the ground is broken, they begin to appear in great numbers and only

the most constant vigilance on the part of the cultivator can keep them from taking full possession. Their seeds, like those of most weeds, germinate during damp weather by merely being in contact with the surface of the soil, in fact if they are buried a couple of inches they will not grow. So omnipresent are these pests about our homes that they seem to be an example of the "survival of the unfit." One of the sumacs (*Rhus obtusifolia*) is often seen as a shrub in the pineland and along the edges of hammocks, but in cultivated ground it becomes a small tree, propagating itself rapidly by underground runners and becoming not merely a nuisance but a menace. The same is true of the common and widely distributed woodbine (*Ampelopsis quinquefolia*) and a grape (*Vitis munsoniana*) both of which grow in the edge of hammocks but are spreading alarmingly in tilled ground. These are doubtless kept within bounds in a wild state by forest fires. They bear fruit much more abundantly where the other wild vegetation is kept down, and the birds carry and drop their seeds everywhere.

There are several plants which are naturalized here from the tropics that come up and flourish

The Work of the Strangling Fig, First Stage. Small Stem with Ovate Leaves near Left on Branch of Live Oak. Simpson's Hammock

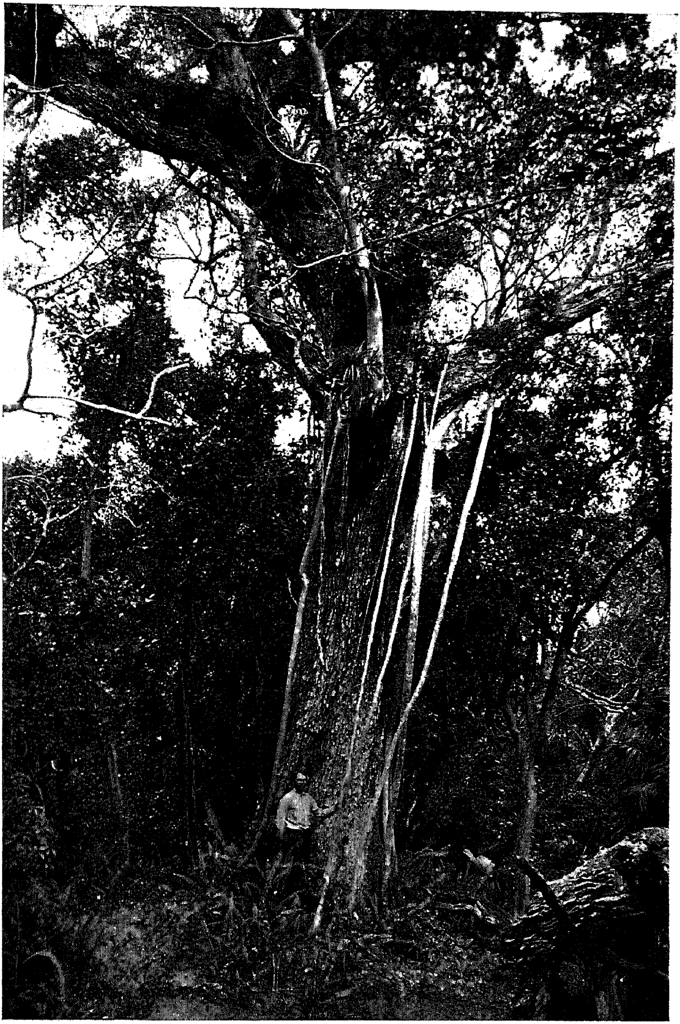
in our grounds and fields that are quite tender and are occasionally frozen to the ground but which seem nevertheless to be very much at home and are firmly established. Among these is the common beggar's tick (*Bidens leucantha*) which is so tender that the least frost cuts it badly. Our yellow elder (*Tecoma stans*) and the common guava have both become completely naturalized, but they are sometimes killed by freezing. No doubt these all find the environment generally congenial and in spite of being seriously injured now and then they are able to maintain themselves.

Along the roadsides is a common weed, a native of India (*Sporobolus indicus*) which takes the place of the northern plantains, as it flourishes best in much trodden places. It is a tough, wiry grass and though it does not bear a bur it is very persistent, driving out other plants wherever it becomes established.

In an early day in Illinois, my native State, the prairies were covered with beautiful flowering plants and nutritious grasses but as soon as settlements were made a great variety of weeds came in and began to take possession of the roadsides, yards, and waste places until it seemed as though

they would exterminate all cultivated plants. Then a plant native in the Northern Alleghanies began to creep in along the roads, pastures, and fields, in fact everywhere; a plant that has proven to be almost as much a boon to the people of the Eastern United States as corn or wheat. It is the Kentucky blue grass (*Poa prætensis*), rich, green, and nutritious. It at once drove out the weeds and has ever since covered the land with a beautiful green carpet. It seems probable that a similar process is taking place in Lower Florida to-day. A handsome grass from South Africa, the Natal grass, with pale green leaves and stems, has been introduced and has escaped cultivation. It was grown for its beauty, the hairy flowers being a rich rose color. In places where it has become established it is driving out our pestiferous weeds and taking full possession. When one looks across a field of this *Tricholæna rosea* towards the morning or evening sun a thrilling sight is presented, a sheet of the loveliest variegated rose imaginable. It is relished by stock, makes good hay, and may be easily killed by the plow.

There are a number of animals in Lower Florida which have developed cunning tricks or ingenious



The Work of the Strangling Fig, Second Stage, Sending Down Roots.
On Great Oak in Cutler Hammock

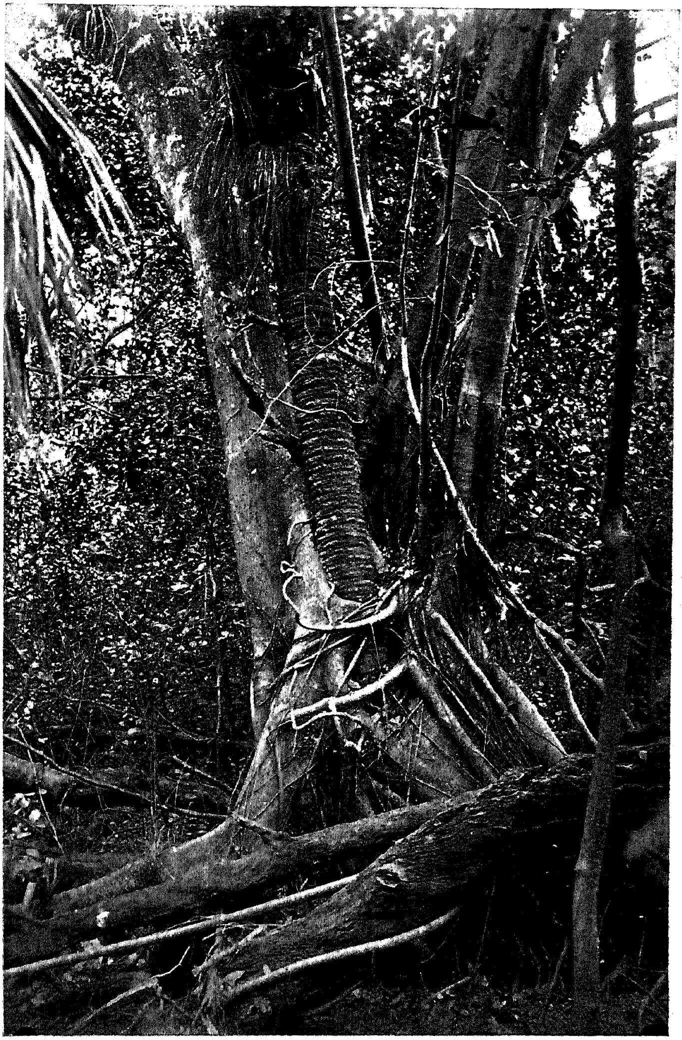
Photo by Wilson Popenoe

devices for their betterment or as a protection against their enemies. We have at least two species of the great sulphur butterflies (Catopsilia) which love the sunlight and are especially abundant in open places. Their flight is exceedingly swift and they constantly move in spirals and zig-zags, so that it is difficult for any bird to capture them.

There is a small butterfly in our hammocks in considerable numbers in autumn and early winter, one of the Eunicas or violet-wings, *E. tatila* probably. The upper side of its wings is shaded with magnificent royal purple; both sides of the upper wings are white spotted, and the under side of the lower ones is smoky colored. It almost always alights on the smooth, brown bark of small trees, closing the wings at once, but leaving the upper ones raised, and in that position the white spots show plainly. Then it slowly opens its wings; the upper ones drop down behind the lower ones and only the smoky under surfaces of the lower wings show. If the color of the bark on which it has alighted is lighter or darker than that shown by the butterfly it slowly changes its tint until it harmonizes with its environment. Once I saw one of these Eunicas alight on a spot where a dark bit

of color on the bark joined a lighter patch and immediately, as though it noticed its mistake, it moved over to the lighter color which more nearly harmonized with it. One of these sitting on the smooth trunk of a tree looks exactly like a small piece of its bark which has become loosened and turned up; this is probably just what the insect intends to simulate. Since I have learned its trick I have been deceived by it repeatedly. *Pyrrhanæa portia*, one of our large butterflies with gorgeous crimson or scarlet wings, attempts almost exactly the same trick but it does not quite so completely conceal itself.

There is a handsome, slender winged butterfly common in our hammocks and shaded areas (*Heliconias charitonius*), our only member of a large family belonging to the American tropics. Its wings are jet black, with irregular diagonal yellow bars. They have a peculiar trembling flight and on account of their abundance are the most conspicuous insect ornament of our forests. One day while sitting by one of the pools in my hammock I saw half a dozen of them hanging to a strand of long moss and apparently dead. The closed wings hung straight down with a decidedly limp appear-



Work of the Strangling Fig, Third Stage. Sending out Cross Roots

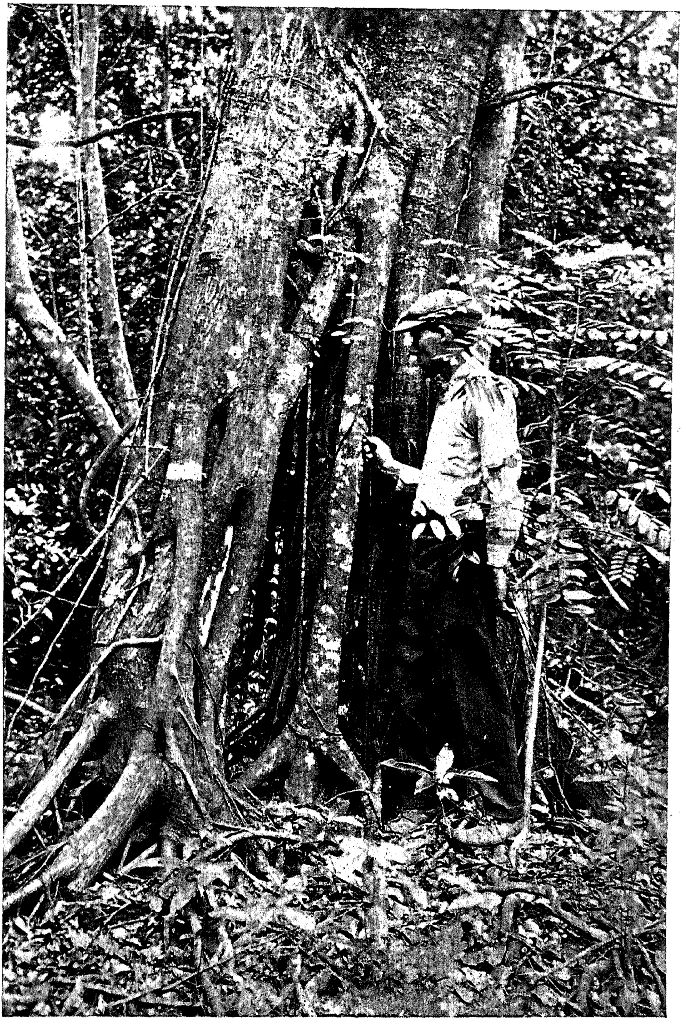
Photo by Wilson Popenoe

ance; the shining black color of flight was now dull, and the yellow bars had turned to a dirty white. I thought I would examine them to see what had happened and to fix the guilt upon a suspicious looking spider. When I reached my hand towards them in a flash the whole lot flew away and began their trembling flight.

They attach themselves in considerable numbers, crowding so close on the moss that they touch each other; in fact I once counted twenty-five of them within a space of ten inches. At times they partly bury themselves in the moss and the irregular wing stripes look almost exactly like the twisted strands among which they are hiding. The ground color of the insect is not at all conspicuous and I have no doubt but that the whole arrangement is a trick to deceive its enemies into supposing it is only part of the long moss. So closely do they mimic their environment that I always have to look closely to be sure whether they are on the moss or not, and so completely do they simulate death that I am constantly being deceived into thinking that they must be dead. Their color returns at once when they recommence their flight.

The Calverts found this same widely distributed butterfly in Costa Rica and during these rests or sleeps it became so dormant that one allowed itself to be picked up, making but little effort to escape. Beebe says that in British Guiana the Heliconias alight on bare twigs, folding their wings and sleeping through the night. In this position they presented no surface to the rain; they also hung edgewise to the direction from which it was sure to come. Ours seem often to be possessed with a spirit of mischief, for when a lot of them have alighted for the night another will come and make repeated dabs at the rest until finally they are all irritated into flight.

I often see a rather large butterfly (*Timetes petreus*), one of the dagger wings, which is an example of protective mimicry almost as wonderful as the celebrated leaf butterfly (*Kallima paralekta*) of the East Indies, which may now be seen in most large museums. Our species has long wings with a rather irregular outline, the ends of the upper pair being strongly curved outwards. When flying it is a most conspicuous object as both surfaces of the wings are a bright rufous red or even scarlet and have three narrow, dark bars



The Work of the Strangling Fig. Last Stage in which the Host is Wholly Enveloped

Photo by Wilson Popenoe

running from near the top of the upper wings to the base of the lower ones. At the extreme lower point of the latter there is a curved, projecting tail and another much longer one above it. Although I often watched closely I could never find it after it alighted in the dense forest. I could see its gorgeous wings as it flew with great rapidity through the hammock; then, as suddenly as the turning out of an electric light, it was gone. One day when I was in the hammock a Timetes flew close by me and vanished within a yard of my face. It seemed to disappear among some dead leaves on a shrub before me and as I peered very closely among them I discovered it, apparently as perfect a dead leaf as any on the bush. The wings were closed and much of the red color had faded, their under surfaces had grown darker and were slightly variegated with a smoky brown exactly the color of the dead leaves. The lower tail was pressed closely against the twig on which it had alighted and formed a perfect petiole. This appeared to be continued up two thirds of the length of the supposed leaf as a midrib. This midrib seemed to be actually raised but I afterwards discovered that it is cleverly composed of color markings, so arranged

that they produce the appearance of relief. At one side there is a notch at the junction of the upper and lower wings which reaches to the supposed midrib, looking exactly as though the old leaf had been torn. About this ragged notch are some small blotches which look precisely like holes made by some leaf-eating insect. The illusion is further carried out by some faint markings of a pale color easily to be taken for the web of the supposed insect. Only the hinder feet of the butterfly clung to the twig and the small body could hardly be seen. In some cases when among dead leaves the Timetes twists its wings so that they are almost contorted and thus increases further its resemblance to a dead leaf. They rely so completely on this perfect camouflage that on several occasions I have picked them up without their making any attempt to escape. I have frequently watched these insects when they were gathering honey from wild coffee and other shrubs and the under surfaces of their wings at such times retain their bright color.

The tiny scales on the butterflies' wings are hollow and a canal connects each of them with the circulatory system. A liquid is injected into

Ficus brevifolia. This Native Tree Sends Down Air Roots and Eventually Becomes a Veritable Banyan

the scales to give them their color, and withdrawn during periods of rest or sleep. This accounts for the slight change in the wing colors of the species I have mentioned when they wish to mimic the object on which they alight, and the regaining of their normal color when they fly.

There is, no doubt, a weeding-out process going on, caused by the severe frosts which occasionally visit the more tropical parts of Florida. The tenderer trees and herbaceous plants are sometimes either killed outright or so weakened that, for a time, the hardier ones gain a decided ascendency. Then a series of mild winters gives the tropical species their opportunity to forge ahead and drive their rivals out, or at least to gain a marked advantage. Several species of plants in a wild state are particularly subject to the attacks of certain insects which may seriously handicap them in the struggle for supremacy or even existence. In this region the wild fiddlewood (*Citharexylum*) is almost constantly attacked by a tent caterpillar which may destroy all the leaves on an entire tree. A small beetle, apparently a Curculio, has for some years pierced the seeds of our native Ocotea, so that I have not been able to find a single perfect

one. If such depredations were to continue unabated through a long series of years they might entirely prevent the plants from propagating and they would eventually be exterminated throughout the area in which they were attacked. In this way we might account for the absence of certain trees and plants in regions where we would naturally expect to find them.

A cold winter or a series of them undoubtedly destroys great numbers of injurious insects and fungi and may check diseases which prey on our plants. Such a winter or winters are followed by an unusually vigorous growth of vegetation, since it has fewer enemies to cope with. This luxuriance of growth and scarcity of enemies gives the survivors an excellent opportunity with a greater share of food and room, and as a consequence the destroyers again wax lusty, multiply with great rapidity, and in a short time the equilibrium of nature is reëstablished and the old order of life is restored.

There are those who believe there is imminent danger that many of our cultivated plants will become exterminated by imported diseases and injurious insects and that unless the strictest in-

spection is kept up and the most rigorous restraints enforced on plant growers, our agriculture and horticulture will totally fail. They forget or do not know that nature constantly tends to produce an equilibrium. Ever since life developed on this planet a never-ending struggle has gone on between the good and bad influences and agencies to build up and develop or weaken and destroy,—the evil and ruinous forces of nature on the one hand and her strength and upbuilding power, her eternal fecundity and virility, on the other. Life flourishes with as much health and vigor now as it did in the old Cambrian days, and there is no reason to believe that it will become extinct or even grow feeble until the cooling off of the sun's heat signals the end.

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Italicized numbers indicate pages on which subjects are discussed.